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THE SCIENTIFIC INSTRUMENT INDUSTRY

THERE have been many conflicting accounts since the conclusion of the War in regard to the condition of universities, technical institutions and other educational establishments in those European countries which either endured long periods of enemy occupation or were over-run by the tides of military operations. Nevertheless, little factual information has been available of the extent to which facilities for education in science and technology survived the six years of hostilities. It was to be expected that, in the general destruction of buildings which has taken place on the Continent of Europe, and, incidentally, in Great Britain, educational establishments would have fared no better than other classes of property. On two other counts, however, it seemed probable that the facilities for the acquiring, and the pursuit, of scientific knowledge would have emerged from the War much impoverished. It was known, in the first place, that it was a policy of German occupation forces, certainly in some European countries, to repress and even to eliminate facilities for cultural advancement. In the second place, the scientific nature of the War gave a special value to scientific equipment and, although the capacity of Germany for the production of scientific instruments was very great indeed, it appeared likely that a large-scale removal into Germany of scientific instruments and apparatus might well have occurred in order to swell the German war effort.

Preliminary information which was obtained through the activities of the Science Commission of the Conference of Allied Ministers of Education indicated that the deficiency in scientific equipment on the Continent of Europe was very great indeed, and that the volume of scientific instruments and equipment required to make good this lack would be equivalent to several years normal output of the British and American scientific instrument industries. In view of the leeway to be made up in the supply of scientific equipment to educational institutions throughout the whole world, it appeared that the problem of European rehabilitation in this respect was one for which only a very long-term solution could be found. It was felt, however, that it might not be unnatural to suppose that the requirement for scientific equipment in the European countries had been over-estimated rather than under-estimated, and from the Science Commission itself came the first suggestion that a mission of inquiry should visit the European countries to obtain first-hand information on their instrument requirements. The mission consisted of British and American personnel, and the report of the two British representatives, Mr. Thomas Martin, who was at the time of the mission deputy director of instrument production in the Ministry of Supply, and Mr. R. W. H. Cooke, of the Directorate of Medical Supplies, has recently been made available. It is a relief to learn from that report, largely written by Mr. Martin, that the task of rehabilitating the countries of Europe in respect

to the scientific equipment of their educational establishments, although a very considerable one, is not so great as to be almost impossible of achievement in any reasonable period of time.

A digest by Mr. Martin of the report of the mission appears on p. 523 of this issue of *Nature*, and there would be little point in repeating facts and figures. Neither is it necessary to direct attention to the high desirability of the rapid and most complete restoration of scientific culture in Europe. It is proposed rather to deal with the implications of meeting this need of Europe for scientific instruments. It is apparent from the report that in the past Europe has, in general, looked to Germany for the supply of scientific equipment; and that, with one or two exceptions cited in the report, the activities of British instrument manufacturers were almost unknown on the Continent. It is, of course, common knowledge that Germany was, before the War, the chief country of the world for the production of scientific instruments. Without entering into the reasons for Germany occupying so predominant a position in respect to scientific instrument manufacture, or discussing the means adopted to maintain the position once it was established, it is relevant to remark that, while it would be most foolish not to admit that the average German scientific instrument was a most excellent product, there was much that was legendary in the very prevalent assumption of superiority of the German instrument over its British counterpart. It is assumed throughout the report of the mission that the European deficiency in scientific equipment would be met from British and American sources, and the exhibition of British scientific instruments recently held in Stockholm (see *Nature*, July 13, 1946, p. 66) gave a clear indication that in respect to quality the Continent was not being driven to use an inferior source of supply. Great Britain has lost much through the War, and it did appear to be a happy circumstance that the scientific instrument industry of the country, upon which the activities of scientific workers and the prosperity of industry are so largely dependent, would be considerably strengthened by the opening to it of European markets which had hitherto been largely closed.

It is therefore very disturbing to find, as is noted in the report, that the British instrument industry is still struggling with two main problems, shortage of skilled labour and inadequate factory accommodation. The shortage of skilled labour results largely from the disappearance during the war years of apprentices and improvers in the scientific instrument firms. This shortage is, of course, being felt in all branches of industry, but the impact on the instrument industry is felt in a peculiar measure, since the proportion of skilled labour in the industry is probably greater than in any other. The position is aggravated by the fact that the demands of compulsory military service make it difficult to remedy the deficiency. The productive capacity of the instrument industry was greatly enlarged during the War, and had the expansion in capacity been of a kind which could be readily maintained, it might have been that Great Britain's share in the re-equipment of European institutions for the teaching of science might have been carried out without undue difficulty. It happened, however, that the expansion of the instrument industry largely took place by the requisitioning of factories producing goods which were felt to be non-essential during the war period. These factories are now being de-requisitioned, and the instrument industry in Britain is now, in fact, a contracting one. In addition to the two main problems mentioned in the report, there is a third one, namely, the shortage of raw materials; and the dislocation in planned production resulting from uncertain delivery of raw materials not only limits the degree of production but also adds considerably to its cost.

The issue of the report, with its indication of a large requirement on the instrument industry of Great Britain for the provision of scientific instruments and apparatus in countries which formerly had other sources of supply, raises the question of the future state of the industry and of its ability to meet with smoothness the demands which will be made on it. These demands fall into three main categories. There is the provision of instruments for the teaching of science in the universities and technical institutions, and for the prosecution of research in those institutions and in other research establishments. It is probably true to say that, in the past, the man of science has not been very concerned as to where he obtained his instruments so long as he could obtain them; but there can be no question that, on the grounds of convenience and of certainty of supply in all circumstances, it is highly desirable that scientific workers in Britain should in general be equipped from British sources. In the second place, there is no greater factor in achieving high efficiency in industrial production than very complete instrumentation. For example, fuel economy can only be fully achieved through adequate instrumentation. In this competitive world, efficiency of production is essential and, therefore, in respect to an adequate export trade, inadequacy in the instrument industry may have alarming implications. Lastly, the scientific instrument itself provides a most economic article of export, since the cost of a scientific instrument rests not in the value of raw materials but almost entirely in the results of skilled labour. If the industry finds difficulty in meeting the demands made upon it from the Continent of Europe, there must be foreboding as to its ability to play its vital part in the life of Great Britain in the future.

No one would wish to question the correctness of the urgency of priority given to such projects as housing; but it would be a pity, and in fact almost absurd, if the application of such priorities be made rigidly and automatically, thus preventing the instrument industry from receiving the necessary materials and facilities; for this industry must provide essential equipment required to enable science to play its full part in the rehabilitation of every phase of the national life. Indeed, the achievement of priority projects themselves may be delayed through the producing industries being denied any one of the prime means of working at full efficiency. There are implications in this report upon the needs

of European countries for scientific instruments and laboratory equipment, which provide grounds for serious thought as to whether adequate consideration has been given to the maintenance of an instrument industry in Great Britain capable of meeting every demand made upon it; and whether, as stated in the preamble to the report, it is not unreasonable to ask that special consideration should be given to the post-war problems of this small but vital industry.

FIBRE PHYSICS

Contribution to the Physics of Cellulose Fibres

A Study in Sorption, Density, Refractive Power and Orientation. By P. H. Hermans. (Monographs on the Progress of Research in Holland during the War, No. 3.) Pp. xvi + 224. (Amsterdam, Brussels, London and New York: Elsevier Publishing Co. Inc., 1946.) 3.50 dollars.

THE trend of fibre research to-day is towards a clearer understanding of the parts played by the crystalline and non-crystalline fractions in determining the properties of the fibre, and this is the theme of Dr. Hermans' monograph. It may be said at once that he has chosen to consider, perhaps wisely as a beginning, those phenomena for which the properties of the fibre may reasonably be supposed to be additive with respect to the behaviour of the two fractions. The physical ideas on which he bases his discussions are of the simplest kind, and even if one feels that he sometimes tends to over-simplification, one cannot but admire his astonishing faculty of getting the most out of such elementary postulates.

At the outset Hermans admits that the partition of the fibre into two fractions is by no means absolute; as a working hypothesis, however, he interprets the term 'crystalline' in the strict sense, as giving rise to coherent diffraction of X-rays. Those cellulose chains, or parts of chains (he rejects the micellar theory in favour of the network), which are not included in the crystalline regions are assumed to combine statistically to give an average behaviour which as a first approximation is independent of the source and modification of the fibres. This dichotomy is, however, to be regarded as schematic, and is justified only if it provides a reasonable interpretation of the experimental results.

Hermans' ideas on water adsorption are best explained with reference to fibres containing 'Cellulose II', that is, regenerated and mercerized fibres. Having established the fact that the lattice dimensions of crystalline Cellulose II change with the water-content ('regain') of the fibre, he associates this with the formation of a hydrate (I) with a water content of 3·7 per cent. This hydrate is also formed in the 'amorphous' fraction, but here a second hydrate (II) (14·8 per cent water) is possible as well. The idea of hydrate II is based on the X-ray result that under suitable conditions a third cellulose modification—the so-called 'water-cellulose'—is possible. A relatively simple picture of the 'chemically bound' water is obtained in this way; it carries the adsorption isotherms up to a relative humidity of about 65 per cent. Native cellulose differs from Cellulose II in that in it only the non-crystalline fraction takes part in the sorption; the mechanism of water uptake is, however, the same in this as in the corresponding fraction of Cellulose II.

Arguing from the remarkable similarity in the shapes of the isotherms for various kinds of cellulose fibres, it is claimed that the ratio of the regains of any two fibres at any humidity will also be the ratio of the non-crystalline percentages in the fibres; regenerated fibres are thus found to contain about twice the percentage of 'amorphous' material as native fibres, whereas mercerized cellulose lies almost exactly midway between these extremes. At the lowest regains two results are noteworthy: the values of the sorption ratios of regenerated fibres relative to cotton tend to rise above their mean values, as would be expected on account of the formation of hydrate I in the crystalline Cellulose II; and the differential heat of adsorption for dry viscose is the same as for cotton, which should be so if the initial water uptake is due to the formation of the same hydrate in both fibres.

The question as to what is the correct immersion medium to use in measuring the density of textile fibres is still, apparently, unsettled. Water, organic solvents, and helium have all in turn been advocated, and until recently Hermans belonged to a school which favoured a reversion to water; but now he has taken a further step in the second cycle and prefers the organic solvents. From his point of view these score in comparison with helium because they are more likely to give different densities for fibres containing different amounts of crystalline material; and his results do, in fact, show that there is a close inverse relation between dry fibre density and sorptive power (which, of course, he has already linked up with the 'amorphous' percentage). The well-known rise in the density at low regains, formerly attributed to an increase in the density of the adsorbed water, Hermans explains simply as a geometrical packing effect of the water molecules fitting into inter-chain spaces in the non-crystalline fraction. This idea receives some support from the observed negative correlation between the dry density and the apparent density in water of regenerated and mercerized fibres; but native fibres do not fit into the scheme at all well, and Hermans concludes that it is not yet possible to give a quantitative interpretation of the observed densities in water for all cellulose fibres.

In the chapter on the optics of cellulose fibres much use is made of Gladstone and Dale's rule, which is shown to be of wide validity if applied to the *mean* refractive index of dry fibres. It is also the basis of a simple theory giving a very good quantitative interpretation of the optics of moist fibres. This assumes the additivity of the polarizations of the cellulose and water, a simplification which seems to give good results but which may not appeal to all readers. In the section devoted to the effect of orientation on the refraction one feels that had more consideration been given to other native fibres than ramie, and in particular to cotton, the sense of anticlimax engendered by Hermans' final admission that native and regenerated fibres cannot be included in the same simple scheme would have been avoided.

The last chapter is devoted to crystallite orientation, and here we may only note that as a result of his analysis of the 'optical' and 'crystallographic' orientation factors Hermans is able to set a limit, not as yet very accurately, to the value of the 'crystalline/amorphous' ratio. In regenerated fibres not more than one third of the fibre substance can be crystalline.

No mention of Hermans' work would be complete without a reference to his admirable experimental techniques, which are described in considerable detail in a series of appendixes. Altogether we must congratulate Hermans on his stimulating account of these researches carried out under conditions which at best could not have been very encouraging.

H. J. WOODS

MAMMALIAN REPRODUCTION

Patterns of Mammalian Reproduction

By Prof. S. A. Asdell. Pp. xiii + 437 + 12 plates. (Ithaca, N.Y.: Comstock Publishing Co., Inc.; London: Constable and Co., Ltd., 1946.) 5 dollars; 27*s*. 6*d*. net.

REPRODUCTION is a branch of biology in which the methods of the naturalist and the anatomist have contributed considerably to an understanding of basic physiological processes. The comparative study of breeding seasons has given valuable clues to environmental and other factors which condition their variation. Differences in the characteristics of the œstrous cycle, and in the manner of ovulation, have directed attention to mechanisms that underlie the overt anatomical and behavioural changes in the reproductive rhythm. In its turn, anatomical and embryological study has provided useful indications for the experimental elucidation of such problems as the differential sensitivity of tissues to hormone stimulation. To-day, however, the broad zoological basis of the subject sometimes tends to become obscured by the more rapidly growing biochemical and physiological literature, and there is a danger lest a declining interest in systematic zoological study robs endocrinology of some potential points of advance.

The value of the comparative approach to the study of reproduction is admirably brought out in Prof. Asdell's "Patterns of Mammalian Reproduction". In it he has assembled, from the literature of natural history, zoology and physiology, such information as is worth recording about the sexual physiology of mammals. About two hundred species are dealt with in the text, while information relating to some seven hundred more is pulled together in the form of tables. The domestic mammals, and those most commonly used in laboratory work, are treated in detail. In the case of the rat, for example, Prof. Asdell has in effect produced a review of practically all that is known about the reproductive physiology of the species—including a detailed statement about the histology of the reproductive organs; it runs to some twenty pages and has a separate bibliography of 150 titles. In the case of such lesser-studied mammals as the African buffalo or the flying squirrel a paragraph or two summarizes what is known about the normal mating and breeding seasons, and about any special characteristics of the reproductive system. The tabulated material gives such information as exists about breeding season, number of young and duration of gestation in the species about which least is known. All this material is preceded by an introductory chapter which provides a general summary of such matters as sex-determination and differentiation; the hormones concerned in reproduction; the underlying pattern of, and changes in, the œstrous cycle of the reproductive organs; and pregnancy.

Prof. Asdell does not tell the reader which scheme of zoological nomenclature he has followed in his path through the Mammalia, and he provides few alternative systematic names. Little difficulty should, however, be experienced on this score by English readers with access to a modern systematic list of the kind issued by the Zoological Society of London.

In selecting his sources Prof. Asdell has wisely concentrated on the most important studies of each species, and particularly on those which emphasize the quantitative aspects of the subject. It is not improbable, as he suggests, that here and there specialists may find omissions in his record. Whether or not they do, no student of reproduction can afford to do without his new book. This will undoubtedly be the reward for what must have been a great labour of compilation, and one which, happily, helps to bring up to date the opening chapters of Dr. F. H. A. Marshall's classical study of the "Physiology of Reproduction", the last edition of which appeared in 1922.

S. ZUCKERMAN

NATURE CONSERVATION IN THE BELGIAN CONGO

Animaux protégés au Congo Belge et dans le territoire sous mandat du Ruanda-Urundi

Par S. Frechkop, en collaboration avec G. F. de Witte, J.-P. Harroy et E. Hubert. Pp. xxi+469. (Bruxelles: Institut des Parcs nationaux du Congo Belge, 1941.)

THIS work is the second edition of what is in effect a guide to the protected mammals and birds of Africa, as well as a handbook of Nature preservation in the Belgian Congo. More than two hundred pages of it are taken up, often with considerable waste of space, by the proclamations, laws and local by-laws which govern field sports, Nature conservation and national parks in Belgian territory. The remaining three hundred pages constitute a guide to the protected species of mammals and birds (and one fish), designed to provide the traveller and sportsman with a means of identification; together with brief notes on distribution, habitat and habits. Much detailed and more technical information, such as particulars of sub-species and local forms, is appended in a valuable series of footnotes. The book displays a curious formality and inelasticity of treatment. Thus, dichotomous keys are provided throughout. Since practically all the species of large herbivores are protected, the keys concerned with these groups are distinctly useful. But, when we come to the birds, only a very small, seemingly haphazardly chosen, proportion of the total avifauna is preserved, so that the keys to this group are of relatively little value.

Each species is illustrated by pen drawings, often based on photographs or taken from published pictures or papers. Apart from some notable exceptions among the mammals, they tend to be wooden and harsh, and give the book an antiquated and rather stuffy air. Some good photographs and some attempts at an ecological approach, with pictures of types of habitat, would have considerably increased the usefulness, educational value and attractiveness of the volume. Whatever the subject, the scale of each illustration is given as a fraction of the natural size—leading to some quaint results. Thus, it is

reasonable to be told that the drawing of, for example, a nightjar, is two-fifths natural size, but it is singularly useless and rather comic to see beneath an illustration of a charging bull elephant the words: "Environ 1/37 de la grandeur naturelle"!

There are many other minor points that might justifiably be criticized, but equally it would be unjust to lose sight of the great achievement in enlightened Nature preservation that the volume represents. British zoologists will indeed have reason for satisfaction when the British Colonial Office shows even a small part of the intelligent enterprise and enthusiasm for Nature conservation which has so long been manifest by the Belgian Government; and when we realize that this volume bears the date '1941' it is not easy to find words to express our admiration.

W. H. THORPE

ASTRONOMY AND HUMAN THOUGHT

The Stars and the Mind

A Study of the Impact of Astronomical Development on Human Thought. By Dr. Martin Davidson. Pp. x+210+8 plates. (London: Watts and Co., Ltd., 1947.) 10*s*. 6*d*. net.

IN this book the author discusses the effect of astronomical developments on human beliefs, and in addition gives an outline of the history of the science from the earliest times to the present day. The latter occupies about two thirds of the work and constitutes a valuable and comprehensive survey, illustrated by interesting plates and several diagrams.

In the opening chapters, an estimate is made of the worth of the Chinese, Chaldean and Egyptian contributions to astronomy. A short chapter on the uncertainty of the subject of Hindu astronomy is followed by a full appreciation of the Greek thinkers and their measurements, including the compendium known as Ptolemy's "Almagest". Throughout the historical survey, the impact of ideas on human beliefs is not overlooked, and in particular two chapters are devoted to Hebrew astronomy, including the origin of the Jewish week—a mystery which at present remains inexplicable. Special attention is given to the work of Copernicus, Tycho Brahe, Kepler and Galileo. The chapter on Newton concludes with a reference to deism. "From Newton to Recent Times" covers the period from the establishment of the Royal Observatory at Greenwich in 1675 to the work of modern cosmogonists.

The remainder of the book deals in some detail with the impact of astronomical developments on the Christian faith. The author finds it hard to agree with Dr. Barnes' contention that the progress of science has not forced us to admit any mistakes in Christ's views of God or of man's relation to God. Dr. Davidson directs attention to the influence that current Jewish ideas concerning the universe had on early Christian belief concerning the imminence of the end of the world, and advocates the recasting of all theological doctrines which rest on the geocentric theory of the universe. Modern astronomy has tended to modify views of 'the Fall', and the author examines at some length Canon Peter Green's work, "The Pre-Mundane Fall". Special attention is also given to "The Beginning and End of the World", by Sir Edmund Whittaker. In view of Whittaker's argument that the law of entropy involves a 'creation', Dr. Davidson devotes a complete chapter (17) to the "Second Law of Thermodynamics and the Beginning of the Universe", in which not only Whittaker's views are discussed, but also the principle of the conservation of angular momentum, especially in relation to Jeans' tidal theory; and further, the question is raised as to how far the second law of thermodynamics has a universal application.

A short chapter on "The Expanding Universe" is followed by one on "How the Heat and Light of the Stars are maintained", and this includes some explanation of atomic structure.

In concluding his interesting book, Dr. Davidson urges the need "to adjust our view of the processes of the universe and of the place of human destiny to a new framework of knowledge". He claims that every religion, every philosophy is based ultimately on a conception of the cosmos, and his frank statements of the implications of astronomy concerning such conceptions should stimulate both philosopher and theologian in the task of relating their beliefs to the trend of modern scientific development.

H. D. ANTHONY

JEWISH PHYSICIANS AND MEN OF SCIENCE THROUGH HISTORY

Jewish Luminaries in Medical History

By Prof. Harry Friedenwald. And a Catalogue of Works bearing on the Subject of the Jews and Medicine from the Private Library of Harry Friedenwald. Pp. viii+199. (Baltimore, Md.: Johns Hopkins Press, 1946.) 3 dollars.

DR. HARRY FRIEDENWALD, professor emeritus of ophthalmology in the University of Maryland, has added to his two-volume work "The Jews and Medicine" (Baltimore, 1944; reviewed in *Nature*, **156**, 31; 1945) a third volume entitled "Jewish Luminaries in Medical History".

This volume, equal to the former publication in beauty and accomplishment of production, embodies an address containing new material on Donnolo, Maimonides, Amatus Lusitanus and others, down to Moritz Schiff and Paul Ehrlich. It refers to the wide contribution made by the Jewish medieval physicians to astronomy, notably to Mashallah (770–820), whose "Astrolabe" formed the source of Chaucer's treatise, to the Jewish physicians who were commissioned in the thirteenth century by King Alfonsus X to compile the "Alfonsine Tables", and to Zacutus the Elder, who, at the end of the fifteenth century, wrote his "Almanach", a copy of which was carried on his voyages by Columbus. An astrolabe made by Zacutus was put to practical use by Vasco da Gama. Bonet de Lattes, physician to several popes, published in 1493 a description of his astronomical ring-dial. Friedenwald's essay is followed by a catalogue of the author's unique collection of books bearing upon the subject of "The Jews and Medicine". The collection was started by his father in 1858; it consists of (*a*) the writings of individual physicians and publications concerning them, and (*b*) the more general works of reference.

The catalogue, replete with biographical and bibliographical detail, forms an indispensable source for the historian of science and medicine.

W. PAGEL

Earth, Moon and Planets

By Fred L. Whipple. (Harvard Books on Astronomy.) Pp. vii+293. (London: J. and A. Churchill, Ltd., 1946.) 18*s*.

THIS is one of a series of books from Harvard Observatory, all of which are compiled by specialists in their own particular sphere. The present volume gives up-to-date information about the bodies in the solar system, and as it is written in language which is almost entirely free from technicalities, it will appeal to a wide circle of readers. The author devotes some space to a consideration of origins and evolution, especially to the origin of lunar craters and to the origin of the planetary system. He favours the volcanic theory of the formation of craters on the moon, but admits that meteors may be responsible for the more recent craters—those with ray systems and some of the whiter ones, and also for many of the craterlets and crater pits. In dealing with the origin and evolution of the planets in Chapter 14, he examines the arguments for and against the planetesimal hypothesis of Chamberlin and Moulton and the tidal theory, and gives his opinion in favour of a fairly rapid condensation as more probable than an accretion; but he admits that the choice between the two processes is not conclusive as the problems are complex.

A most valuable feature of the book is the planet finder and the star chart by means of which the positions of the planets can be located up to 1970. This portion will prove most helpful to many readers who want to know the positions of the planets from month to month.

The book is well illustrated by 140 figures, more than half of which are photographs.

Some minor corrections should be made in the next edition. It is usual now to accept the Astronomer Royal's recent determination of the solar parallax and to adopt 93,005,000 miles, not 92,870,000 miles (p. 3), as the astronomical unit. Although the 1931 approach of Eros is mentioned on p. 48, Hinks's value for the solar parallax is given. The extra motion of the perihelion of Mercury's orbit is more nearly 43″ per century than "about 50″" (p. 28). The velocity of escape from the solar system (presumably at the distance of an astronomical unit from the sun) is not 45 but 26 miles per second (p. 78). Further, meteors do not move with velocities of 45 miles per second relative to the sun (p. 78); this is their maximum velocity relative to the earth.

M. DAVIDSON

Statistical Analysis in Biology

By Dr. K. Mather. Second edition, revised and enlarged. Pp. iv + 268. (London: Methuen and Co. Ltd., 1946.) 16*s*. net.

THE profound effect which R. A. Fisher has had on the interpretation of biological data has been mediated through a book which most biologists can only dimly understand at first. The meanings of the new ideas put forward in this book are often not fully explained; but the interested reader is stimulated to think them out for himself. More detailed expositions of many of the new statistical methods are contained in various other books; but Dr. Mather's book is, so to speak, the authorized version. The author is primarily a biologist; but he has evidently devoted much thought to the meaning of the quantities that can be calculated from a set of data and their relation to one another. His book is illustrated with examples, and the reasoning is given at length so that much of it can be read fairly rapidly.

This book has been out of print for some time and the new edition will be welcomed. It is much the same as the first edition except that it contains a valuable new chapter dealing with two transformations which may be applied to percentages — $p = \sin^2\phi$ and probits. In each case, the method is explained and one example is worked out.

The Bathe

An Ecstasy. By Marie Carmichael Stopes. Pp. iv + 19. (London: Alexander Moring, Ltd., 1946.) 5*s*.

OF the lyrical quality of this poem, as indeed of all Dr. Stopes' verse, there is no question. From the first apparently effortless stanza:

"Brown rocks have sucked in all the sun's warm rays
To over brimming, till they fill the air
To fine enraptured whirlpuffs gliding where
They quiver up the bank of sheltered bays",

continuing through the whole poem with the same musical consistency. Phrases slip into place with the same facility as their author appears to glide into the sea. Students of form would benefit by observing such unobtrusive craftsmanship.

"An Ecstasy" is no idle description; here is a spirit bubbling with almost youthful ebullience, whose flight is as spacious as it is melodic.

Individual lines are admirable:

"And lave my feet among these lambent pearls." "The swirl subsiding silence broods in me." "Deep clarity of blue translucence calls more than my body to be permeate."

But the author's enraptured journey tends to veil her powers of discretion. Imagination is not necessarily art.

"Soon my salt tanged palms
Vie with intoxicating scent brewed balms,
To yield sweet odours to the sun drenched sky.
Short golden hairs, minutest flagstaffs rear
Each on its tiny mound, but soon they cling
Content to nestle close like folded wing."

Avoiding this misguided sensuousness, Dr. Stopes would be a poet of quality, and a stronghold for readers who deplore the absence of buoyancy in modern poetry.

MARGARET HOWARD

Reports of the Progress of Applied Chemistry

Issued by the Society of Chemical Industry. Vol. 29. 1944. Pp. 574. (London: Society of Chemical Industry, 1946.)

THE present volume of this very useful review of the progress of industrial chemistry contains the usual sections. A notable feature is the inclusion of statistics in many cases where these had been held up during the war period. Those on coal make dismal reading. The abstracts are usually quite brief, so that it is scarcely possible to select any topics for special mention. Attention may perhaps be directed to some interesting information on moth-proofing (p. 91), on molecular weights of cellulosic materials (p. 101), plastics (p. 255), soils and fertilizers (p. 364), foods (p. 418), and fine chemicals and medicinal substances (p. 450). Many of these topics, it will be seen, are of general interest in various fields. The volume contains a very large amount of information and is well produced and indexed.

SCIENTIFIC EQUIPMENT IN EUROPE: PRESENT NEEDS

THE report has recently been issued* of a small Anglo-American mission which visited the devastated countries of Europe during the period February–June, 1946, for the purpose of finding out their needs of scientific instruments and laboratory equipment. This report has been prepared by the British members of the mission, and is based on a tour of twelve different countries. It has been made available by the Ministry of Supply for the information of those concerned, on the understanding that the opinions expressed and recommendations made are those of the authors and not of His Majesty's Government.

The countries visited, in the order named, were France, Switzerland, Italy (southern), Greece, Italy (northern), Austria, Czechoslovakia, Belgium, Holland, Denmark, Norway, Poland and Sweden. It had been intended to visit Jugoslavia, but this visit was reluctantly abandoned as the American members of the mission found it impossible to obtain visas at the time they were required. The two neutral countries, Sweden and Switzerland, were included in the tour because they are potential suppliers of some of the equipment, and also because their own needs cannot be disregarded in any assessment of European requirements.

The first suggestion of sending the mission arose at the meetings in London during the War of the Science Commission of the Conference of Allied Ministers of Education, of which the late Dr. E. F. Armstrong was chairman. Accurate information was required as to the conditions in the European countries at the end of the War. Moreover, it was considered that, in the immediate post-war period, the United States and Britain must necessarily be the principal sources of supply of the instruments and equipment needed for educational rehabilitation. The American and British Governments were therefore approached, and eventually the State Department nominated Mr. Wendell R. Turner of the Department of Commerce and Dr. James L. Thomas of the Bureau of Standards as the American representatives on the mission. The British Government appointed two officers of the Ministry of Supply, Mr. Thomas Martin, at that time deputy director of instrument production, and Mr. R. W. H. Cook. The mission was dispatched with the objects, first, of ascertaining as closely as possible the extent of the war losses of scientific instruments and laboratory equipment from universities, research laboratories and schools, and secondly, of bringing back as much information as possible as to the nature and extent of the rehabilitation requirements, to enable the instrument industries of Britain and the United States to make plans for meeting the demands. There was the incidental purpose of giving some lead to the industries of the two countries as to the export opportunities in this field, in view of the (at least temporary) elimination of Germany from the European market.

Much interesting information was obtained by the mission, and not the least valuable feature of the tour was the opportunity it afforded, soon after the end of the War, of comparing the conditions in the different countries. A separate section of the report is devoted to each country visited, and certain general considerations and conclusions in regard to the tour as a whole are set out in the introduction.

The report discloses extremely serious losses and shortages of equipment in many countries; but the opinion is expressed that there has been a tendency to exaggerate the extent of the losses as a whole. In one country, Poland, it would be difficult to exaggerate the extent of the destruction or the urgency of the need. Losses of equipment in Greece are scarcely less serious, but the problem of replacement is much smaller; while in Italy the destruction is very severe. On the other hand, certain countries actively engaged in the War have escaped relatively lightly as regards educational losses; for example, France and Norway. In all the countries, however, there are heavy arrears of normal requirements.

The value of the replacement requirements of the countries visited is estimated at not more than £18 million and not less than £14 million*. This total does not include Jugoslavia, and it was thought undesirable to include in the report any estimate for the two neutral countries, Sweden and Switzerland. Moreover, the estimates are in general based on 1939 values. When all allowances are made, however, the figure is still very much below estimates which were current before the mission left England.

Only a proportion of the total is likely to be called for from Britain and the United States in the immediate future. Some countries have considerable instrument-making resources of their own. In others there is uncertainty as to the extent of relief grants for educational rehabilitation, and as to the application of priorities in the utilization of funds or credits available. Shortage of foreign exchange is likely to limit overseas buying by most of the countries for a considerable time to come, and generally those with the greatest needs have the slenderest resources.

Intense interest in Anglo-American technical progress during the War, and a desire to fill the gaps in scientific knowledge caused by the cutting of communications during the German occupation, were everywhere manifest. In several countries sentiment was strongly in favour of obtaining scientific instruments and equipment from Britain and the United States and of breaking the previous German connexions in education and science. Resentment at German ill-treatment, for example in Holland, conduced strongly to this tendency. It must be said, however, that in the Scandinavian countries, and particularly in Norway, a different point of view was held. Many Norwegians wished to see German industry compelled to produce, and supply by way of reparations, the equipment urgently needed by the Allied countries. The dangers of a revival of the German instrument industry and of the virtual German monopoly of the Continental market were discounted or disregarded.

Whatever may be the opinions on this point, there can be no doubt that in Great Britain we have at the present time both a heavy responsibility and a remarkable opportunity in regard to the educational rehabilitation of Europe. It must be recognized,

* Report upon the Needs of European Countries for Scientific Instruments and Laboratory Equipment. Ministry of Supply (E2), October 1946.

* The estimate of £9 million mentioned in *Nature* of January 25, p. 110, referred to a report apparently made for the United Nations Educational, Scientific and Cultural Organisation. EDITORS.

however, that in many countries very little is known of the resources of British instrument-making. There are notable exceptions: the instruments of one or two British firms are to be found in nearly every physics and chemistry laboratory in Europe; but the other makers are not well known to Continental users. In the case of survey instruments, for example, German and Swiss manufacturers have held the field so completely that the long-established and high-quality production in Great Britain is unknown. The position is very little better in regard to microscopes.

Recommendations are made in the report with the view of correcting this state of affairs, particularly the setting up of more effective agencies for the British instrument industry in the principal cities of Europe. These should be well provided with instruments as well as literature, and have adequate servicing facilities; and it is suggested that a special study should be made of the commercial peculiarities and methods of ordering in the different countries. Reference is made to the very successful exhibition of British instruments held in Stockholm in May 1946, which was highly appreciated in Sweden; and the holding of further exhibitions in other countries is strongly advocated.

As to the nature of European requirements, the following passages are best quoted in full:

"It can be said with certainty that there is no type of scientific equipment which is not wanted somewhere in Europe; but we early found that it would not be practicable to bring back anything in the nature of detailed lists with quantities attached for each country. So varied are the needs and so dependent the ordering is likely to be on local conditions and personal preferences that such statistical information is generally not available in the countries themselves. Much miscellaneous information bearing on the needs of particular institutions is however given [in the separate reports for each country].

"Apart from this there are certain general shortages to which attention must be drawn. In nearly every country of Europe there is a serious, and in some cases an acute, shortage of laboratory glassware, that is to say, beakers, flasks, funnels and test tubes, particularly in the heat-resisting varieties, as well as graduated glassware, glass tubing and rod, and glass apparatus of all kinds. There is an equal shortage of laboratory porcelain, and of miscellaneous laboratory supplies—filter papers, rubber tubing, corks and the like. In many countries too, stocks of chemical reagents are long since exhausted, and further supplies, particularly of pure reagents, cannot be obtained. It is no exaggeration to say that in many parts of Europe the experimental teaching of chemistry is at a standstill because of these shortages of consumable laboratory supplies.

"As to direct war losses, heavy equipment, while it may have been damaged, for example by the stripping of non-ferrous metal components, has often been left and is repairable; but instruments of a portable character, such as microscopes, spectroscopes, lenses and photographic equipment, balances, galvanometers, resistances and small electrical instruments of all types, have everywhere been looted. Of all such instruments, large numbers are wanted in every country.

"Another serious shortage is of metal-to-glass equipment, that is, radio valves, X-ray tubes, cathode ray oscillographs, discharge lamps, rectifiers and so forth.

"Interest in war-time technical developments, particularly radar and atomic physics, will cause a demand for new equipment in many places. We saw cyclotrons in five different countries, and heard of others building. . . . High tension plant, Wilson chambers and their accessory equipment, hydrogen and helium liquefiers, compressors and vacuum pumps will all be wanted."

A shortage which was not strictly the concern of the mission, but which was everywhere apparent, was that of scientific and technical literature, particularly British and American text-books, journals and periodicals. In every university library the gaps in the shelves for the volumes from 1939 onwards were pointed out, and many of the professors regarded this as the most serious shortage of all. The problem of the back numbers and missing text-books is so serious and so important to science that a special and concerted effort is clearly needed to ensure the printing or re-printing of the missing books.

In the reports on the separate countries the visits to universities and institutions are described, and the conferences with government and other officials are summarized. In certain countries which have suffered heavy losses, among them Belgium, Holland and Czechoslovakia, the energy and initiative with which the problems of educational reconstruction are being tackled are most impressive. In other countries the circumstances are less satisfactory, and again the report may be quoted in full:

"In our report on Poland we have indicated that the destruction and loss to the educational system is so severe, and the resources seemingly so inadequate, that the problem becomes one of a different nature from that in some other countries. Elsewhere there are conditions which are almost, if not quite as serious. It would be impossible for any person of ordinary goodwill to see the state of the institutions we visited in Warsaw, in Athens and in Naples, without wishing that some way could be found to cut through the political and economic barriers which hold up action through the official channels, and bring some direct and immediate assistance to the courageous men and women who are struggling to carry on their work in these places. . . . There are in a few countries, and particularly in a few institutions within those countries, conditions so deplorable, and prospects of relief so remote, as to suggest that there are grounds for special action to relieve the most serious cases."

As to the part the British instrument industry may be able to take in dealing with this urgent problem, it is clear that greatly accelerated production of scientific instruments and laboratory equipment is needed to relieve the shortages in Europe. On commercial as well as humanitarian grounds the production is needed, for early delivery is the important consideration if the export possibilities are to be realized which the situation in Europe presents. Copies of the report have already been put at the disposal of the Council of the Scientific Instrument Manufacturers' Association of Great Britain, which is giving active and sympathetic consideration to its recommendations; but the industry is suffering from grave handicaps at the present time, among them inadequate factory space, shortage of skilled labour, and not least, difficulty in obtaining supplies of basic raw materials. It is much to be hoped that ways and means may be found of enabling this vital industry to continue, into the post-war years of reconstruction, the magnificent effort it made during the War.

THOMAS MARTIN

PEAT, HAY-FEVER AND PHARMACOGNOSY

By Dr. T. E. WALLIS

Curator of the Museum of the Pharmaceutical Society of Great Britain

THAT three subjects so diverse as peat, hay-fever and pharmacognosy should have a common meeting-ground of fundamental importance appears somewhat surprising. The common ground is found in the morphological study of pollen. Pollen grains were first studied in detail about 250 years ago by Nehemiah Grew. On plate 58 of his "Anatomy of Plants" he gives drawings of the pollen of eleven different plants. Grew referred to pollen as the "Particles of the Attire", the "Attire" being the androecium of the flower. He discusses the use of pollen, noting in Book 1 of his treatise that "it is for Ornament and Distinction to us and for Food to other Animals", while in Book 2 he refers to the uses previously discussed as being the "Secondary Uses" and proceeds to say "the Primary and chief Use of the Attire is such as has respect to the Plant itself" and "that the Attire doth serve, as the Male, for the generation of the Seed"[1]. It is clear, therefore, that Grew had a good understanding of the nature and functions of pollen.

During the subsequent two hundred years little advance was made, due principally to the inadequate microscopes in use at that time. However, by the beginning of the nineteenth century much improvement had been effected in microscopes, and the study of pollen was stimulated by the publication of books in which pollen from many plants was more adequately described than had been done previously. Chief among these were: (1) the well-known treatise of Hugo von Mohl, "Über den Bau und die Formen der Pollenkörner", Bern, 1834; (2) the "Micrographic Dictionary", London, 1856, by Griffith and Henfrey, in which there is a good article on pollen illustrated by excellent figures; and (3) a book containing drawings and descriptions of 450 pollens, entitled "Pollen", by M. P. Edgworth, London, 1877. These books and the increasing popularity of the microscope as a means of entertainment in polite society led to a greatly increased interest in pollen either as being objects of great beauty or as providing a means of identifying plants or families of plants (Fig. 1).

Pollen of Peat

Following upon this period, interest began to be taken in the origin of peat, both in Switzerland, where Früh (1885) published an article entitled "Critical Contribution to the Knowledge of Pollen in Peat", and also in Sweden, where Trybom (1888) noted how resistant pollen is to decay and suggested that pollen grains might serve as index fossils in palæontology. Systematic examination of pollen in peat began about 1916 when L. von Post wrote an article upon "Certain Bogs of Southern Sweden". At the present, pollen of peat deposits is regularly examined; the spores and pollen grains are counted and identified and their percentage proportions determined. From the results a good estimate can be made of the type of vegetation present when the peat was being formed, and the relative ages of neighbouring formations can be determined. Other geological problems also can be solved[2].

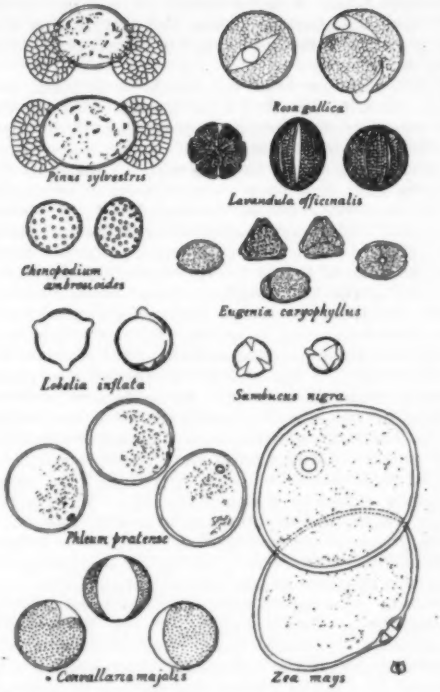

Fig. 1. POLLEN GRAINS FROM PLANTS OF ECONOMIC IMPORTANCE, SHOWING THE VARIETY OF SHAPE, SIZE AND MARKING. × c. 300

Hay-Fever

Three quarters of a century ago, C. Blackley, an English physician, living at Manchester, made experiments to discover the cause of hay-fever, and published his results in a thesis entitled "Experimental Researches on the Causes and Nature of Catarrhus Æstivus". He showed that susceptible persons quickly developed hay-fever when pollens of a large number of plants were applied to the (*a*) nares, (*b*) larynx, (*c*) conjunctivæ, (*d*) tongue and fauces. He also found that pollen of grasses was most potent, that of the common rye, *Secale cereale*, being especially toxic. He gave a list of fifteen families of plants the pollen of which produced hay-fever, and he found that in the month of June the number of air-borne pollen grains was at a maximum, 880 grains being collected on 1 sq. cm. of glass in one day[3].

From 1873 until 1916 this problem was allowed to remain as Blackley left it. In 1916, however, the investigation was revived with vigour in the United States by W. Scheppegrell, and since then it has been developed in that country by making systematic surveys of the atmospheric pollen in many of the States. The results have been collected and extended by Roger P. Wodehouse[4]. He has named a small number of families of plants, grouped in two sets, which he regards as particularly toxic in producing hay-fever; these are: (1) Herbs and Grasses—Gramineæ, Compositæ, Chenopodiaceæ, Amaranthaceæ, Plantaginaceæ, Polygonaceæ; (2) Trees and Shrubs—Betulaceæ, Fagaceæ, Ulmaceæ, Moraceæ, Juglandaceæ, Salicaceæ, Aceraceæ, Oleaceæ[5]. He concludes that the grasses possess the highest toxicity and that, since their toxicities seem to be of

a similar type, it is necessary to use one pollen only for medicinal purposes, and timothy or cat's tail grass, *Phleum pratense*, is considered most suitable.

Pollen surveys were not made in Britain until quite recently, the first ones having been planned and executed at Llandough, near Cardiff, by Hyde and Williams in 1942 and 1944. Pollen was collected on microscope slides smeared with a thin coating of glycerin-jelly, and they were exposed in two ways: (1) in a horizontal plane, 'gravity slide'[6], upon which the pollen fell by gravitation from the atmosphere; and (2) in a vertical plane, kept constantly facing the wind, 'impact slide'[7]. The slides were exposed on the roof of the Llandough Hospital, supported on a stand about 12 in. above the roof-level, and were protected from rain, snow, etc., by a covering about 12 in. above them, stand and cover being about 3 ft. in diameter. At the end of the period of exposure (usually twenty-four hours) the slides were removed, a drop of glycerin-jelly applied and a cover-glass. The pollen grains under the cover-glass were identified and counted. The results were finally recorded in the form of graphs showing variations from day to day over a period of eleven months. The hours of bright sunshine for each day were recorded on the same graph so as to allow of correlation between sunshine and abundance of pollen. It was established that the effective pollen season extends from early March to late September, and that it shows three distinct phases dominated respectively by the pollen of (*a*) trees, (*b*) grasses, and (*c*) dicotyledonous herbs, the major part of the pollen being from anemophilous plants. It was also shown that periods of maximum numbers of pollen grains corresponded with periods of maximum sunshine.

For the modern treatment of hay-fever, an immunizing solution, known as a pollen-vaccine or allergen, is prepared from the pollen of *Phleum pratense* (Fig. 1) or from a mixture of pollens from a few selected grasses such as *Phleum pratense*, *Dactylis glomerata*, *Alopecurus pratensis*, *Anthoxanthum adoratum* and *Poa* spp.[8]. The collected pollen is extracted with ether to remove fatty matter; the residue is dried over calcium chloride or phosphorus pentoxide for several days and is stored until required. The allergen is made by macerating the prepared pollen in physiological saline, mixed with glycerin and phenol or in a special medium composed of sodium chloride 0·5 per cent, sodium bicarbonate 0·275 per cent, phenol 0·4 per cent, and water to 100[9]. The maceration is continued for about eighteen hours in a refrigerator, after which the macerate is filtered off, passed through a Seitz filter pad into a sterile filtering flask, from which it is transferred to sterile bottles for storage. When required for treatment the allergen is filled out into small sterile rubber-capped vaccine bottles. At least three different standards are used for the allergen solutions, the units being (1) representing the extract from 0·001 mgm. of pollen, equivalent to about 80–100 pollen grains and known as a Noon unit; (2) equivalent to 0·00001 mgm. of nitrogen precipitable by phosphotungstic acid; (3) equivalent to 0·02 mgm. total nitrogen per mil. The treatment extends over about three months prior to the pollen-distribution period, the allergen solution being injected subcutaneously, beginning with very small doses and ending with 5,000–10,000 units[10]. Repetition of the treatment for three years in succession is generally necessary for immunization.

Pharmacognosy

Pollen grains are used in the science of pharmacognosy as an aid to the identification of drugs and spices, more especially for determining the sources of different kinds of honey and for the identification of powdered drugs such as cloves and belladonna herb. For all these purposes, the morphology of the pollen grains must be studied and records made of diagnostic characters, such as (1) dimensions and shape, (2) surface characters of the exine, (3) presence or absence of pores and germinal furrows, (4) contents, such as fixed oil and small starch granules[11]. Using these features, pollen grains may be grouped upon a plan such as the following:

(1) No furrows and (*a*) no pores, for example, gymnosperms and *Crocus sativus*; (*b*) one pore, for example, grasses; (*c*) two pores, for example, *Colchicum*; (*d*) numerous pores, for example, *Chenopodium*.

(2) One furrow, no pores, for example, *Convallaria* and many other monocotyledons.

(3) Three furrows and three pores, for example, most dicotyledons.

(4) Six furrows and six pores, for example, lavender and many other Labiates.

The mountant for the pollen is important because the shape and size depend upon its action. The two most useful mountants are solution of chloral hydrate (five of chloral hydrate in two of water) and lactophenol[12,13], both of which affect the pollen in approximately the same way. Chloral is used because it is the mountant in which powdered vegetable materials are most commonly examined; lactophenol is useful because it rapidly penetrates among small particles, thus avoiding heating to remove air-bubbles, and does not evaporate. Permanent mounts are generally made by removing excess of the fluid mountant and substituting glycerin-jelly.

For the purpose of judging the quality and source of honey, pollen has been systematically studied in Germany by Prof. Enoch Zander, who has published

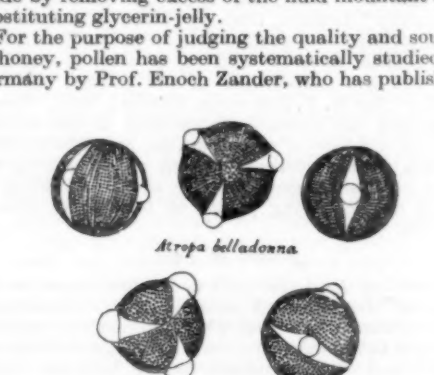

Fig. 2. Pollen grains from plants of the family Solanaceæ. × *c.* 300

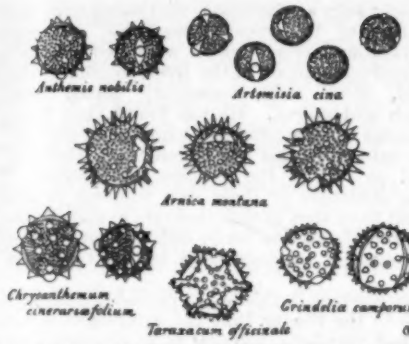

Fig. 3. POLLEN GRAINS FROM PLANTS OF THE FAMILY COMPOSITÆ. × c. 300

descriptions, including measurements, of a large number of pollens, with eighty plates of excellent photomicrographs of some 750 different kinds[13]. The pollen is separated by mixing the honey with water and centrifuging, after which the pollen is mounted in glycerin-jelly. The pollen grains are then identified and counted and a percentage table is constructed; from this a conclusion may be made as to the source of the honey[15].

Although the dimensions of pollen grains are important characters, it is probable that the shapes and markings are more reliable criteria for diagnosis. These facts are immediately evident when one examines the pollen from closely related plants. For example, pollens from the three common drugs belonging to the Solanaceæ (Fig. 2) have the following characters[14]: *Atropa belladonna*, sub-spherical, 37–50 μ in diameter, exine with lines of pits radiating from the poles, three furrows, three pores which are about 8 μ in diameter; *Hyoscyamus niger*, sub-spherical, 40–50 μ in diameter, exine with pits in a scattered arrangement, three furrows, three pores which are about 15 μ in diameter; *Datura stramonium*, sub-spherical, 56–80 μ in diameter, exine coarsely granular, no furrows, three pores which are 15–24 μ in diameter.

Similarly with pollen of compositous plants, the important distinguishing features are the presence or absence of cuticular spines, the length and number of the spines when present, the arrangement of any ridges as in *Taraxacum officinale* and other plants of the Cichorieæ (Fig. 3, and the accompanying table[14]):

Name	Shape	Diameter	Surface	Furrows	Pores	Notes
Artemisia cina	Sub-spherical	20 to 25 μ	Finely granular	3	3	No spines
Grindelia camporum	Sub-spherical	32 to 45 μ	Smooth; spines 2 μ long	3	3	21 spines in the disk
Arnica montana	Sub-spherical	40 to 52 μ	Very finely granular; spines 8 μ long	3	3	16 to 18 spines in the disk
Anthemis nobilis	Sub-spherical	30 to 36 μ	Finely warty; spines 3 μ long	3	3	12 to 13 spines in the disk
Chrysanthemum cinerariæfolium	Sub-spherical	34 to 40 μ	Lines of warts radiating from the poles; spines 4 μ long	3	3	10 to 11 spines in the disk
Taraxacum officinale	Hexagonal-spherical	32 to 40 μ	Smooth spines 2 μ long	0	3	40 spines in the disk, etc.

The spores of *Lycopodium clavatum*, which are used as a dusting powder, as a vehicle for snuffs or insufflations of penicillin and menthol and also in large quantities in pyrotechnics, have an important use in microscopy to enable one to estimate the weights of materials seen in the field of the microscope[16]. The determinations depend upon counting methods based upon the number of lycopodium spores per mgm., which is 94,000[17]. This process is possible because lycopodium spores are very uniform in size, easily identified by their shape and markings and are highly resistant to most common mountants and microscopical reagents.

The study of pollen and spores has therefore yielded details of great economic importance. In addition to the elucidation of academic problems, the study has proved of much value to the advance of medicine and to the analyses of peat, honey, drugs, spices and foods, thus providing the foundation for much knowledge of such diverse subjects as peat, hay-fever and pharmacognosy.

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PROGRESS OF CANCER RESEARCH

By DR. I. HIEGER

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THE British Empire Cancer Campaign has awarded the Garton Medal and Prize of £500 to Prof. E. L. Kennaway in recognition of his outstanding contributions to cancer research. Eighteen years after his discovery of the first carcinogenic hydrocarbon (1 : 2 : 5 : 6-dibenzanthracene), investigators are still synthesizing and testing new carcinogenic compounds although these now number more than three hundred; and in fact studies of carcinogens and their mode of action form the largest single group of investigations in progress in the twenty-one centres of research financed, assisted and co-ordinated by the Campaign.

In the accompanying table, the reviewer has attempted a classification of the investigations described in the twenty-third annual report issued by the Campaign approximately according to their numerical occurrence, but of course this arrangement

is no conclusive proof of priority in any sense. Numerous modifying factors should be taken into account in any more precise evaluation. For example, some of the reports of researches are detailed, some highly summarized; some pursued by a single worker, others by a team; one may represent a project barely begun, another may be one of those long-term investigations which can only give results after several years and where, consequently, one year's report reads much the same as that of the previous year; and finally, the type of research which can take advantage of the fertile technique of organic chemistry is bound to attract more attention than others which depend upon less well-developed techniques. Nevertheless, it is obvious that carcinogenesis by chemical compounds, work on X-rays and radium, and chemotherapy form the largest three groups of investigation.

Carcinogens, their mode of action, factors affecting carcinogenesis, metabolites, carcinogenesis by tar and petroleum	15
Radiology, developments in the use of X-rays and radium, action of radiation on tissues and tissue constituents. Biophysics, use of radioactive isotopes	14
Chemotherapy by stilbene derivatives, œstrogens, urethane and other compounds	7
Filterable tumours	5
Cytology	3
In vitro culture	2
Nucleoproteins	2
Histology	1
Social distribution of cancer	1
Genetics	1
Enzymes	1
Transmissible milk factor for mammary cancer in the mouse	1

Apart from laboratory experiments, much clinical investigation has been pursued at practically all centres, and the Clinical Cancer Research Committee presents an elaborate report of nearly 1,500 cases of cancer of the rectum and anus treated statistically under thirty-five different headings dealing with the pathological, surgical and etiological aspects. Three new projects are being launched by the Campaign this year.

At Edinburgh, a pool of experimental animals is being bred, and transplantable tumours are being kept growing in animals for use by other research centres, much like the national collection of type cultures. The Campaign is producing a new journal, the *British Journal of Cancer*, and virus research in relation to cancer is to receive stimulation by a £25,000 grant, which will no doubt also accelerate experimental work with filterable tumours and in related fields such as the transmissible milk factor for mouse carcinoma, nucleoproteins, and ultra-violet microscopy.

Among the latest carcinogenic compounds to be tested at the Oxford centre are some containing sulphur; for example, 4 : 9-dimethyl-2 : 3 : 5 : 6-dibenzthiophanthrene and 4 : 7-dimethyl-2 : 3 : 5 : 6-dibenzthionaphthene. Such sulphur-containing carcinogens are no doubt already being used in tracer experiments where radioactive sulphur forms part of the molecule. At the same centre, species differences have been sought in experiments where 9 : 10-dimethyl-1 : 2-benzanthracene—to date the most powerful carcinogenic agent known—was tested on mice, rats, rabbits and guinea pigs; but it might perhaps be objected that instead of such sledge-hammer methods the test would have been more sensitive if a less active agent had been used. Some investigator with a sense of humour might try the effect of cancer-producing hydrocarbons upon the crustacean after which the disorder was named so long ago.

Bielschowsky at Sheffield is continuing experiments with one of the most remarkable carcinogens, 2-acetylaminofluorene, which when fed to rats and mice produces cancer in the liver, ductus acusticus, thyroid, blood cells, mammary gland, bladder, stomach and uterus. He has found that 2-amino-anthracene readily produces tumours of the skin in albino rats, and this compound must therefore be classed as one of the simplest carcinogens. The cellular structure of these skin tumours is usually different from that of skin tumours in mice produced by hydrocarbons, and hence different processes must be involved in carcinogenesis by the two types of agent.

Many workers in this field—probably a majority—incline to the theory that the carcinogen, before it can effect neoplasia, has first to be converted by the tissues to an active derivative, which is the true carcinogen. Proof of this theory is, however, somewhat unconvincing as yet. Indeed, what evidence is available points rather in the opposite direction, since metabolic products of the carcinogens have so far shown very little carcinogenic activity. A metabolite of 2-acetylaminofluorene isolated from rat urine, namely, 2-acetylamino-7-hydroxyfluorene, has so far proved inactive as a carcinogen; the metabolite of 3 : 4-benzpyrene, namely, 8-hydroxy-3 : 4-benzpyrene, is only very weakly carcinogenic, but if the hydroxyl group is converted to methoxy, the new compound is then strongly carcinogenic. It must be noted that to speak, as some do, of 'methylated metabolite' conveys a little ambiguity, because the methylation takes place in the test-tube, but the metabolite is generated *in vivo*. Moreover, Dickens has tested the carcinogenity of the 'methylated metabolite' from 9 : 10-dimethyl-1 : 2-benzanthracene and finds it (4'-methoxy-9 : 10-dimethyl-1 : 2-benzanthracene) inactive.

At Glasgow, Peacock and his colleagues have, among much other work, extended the study of co-carcinogens to gastric cancer. By adding one of these substances, croton oil, to the diet of rats, hyperkeratosis of the stomach, but not cancer, was produced; and even if a weak carcinogen were added to a diet containing an irritant (pepper), tumours were not found at post-mortem. No mention is made of results with a combination of croton oil and weak carcinogen added to the diet, but perhaps such tests are already in progress.

At Leeds, Orr has found that when methylcholanthrene is applied to the skin of mice of the *IF* strain (highly susceptible to skin cancer induced by hydrocarbons, but not liable to spontaneous mammary cancer), cancer of the mamma and pulmonary adenomata were found in every experimental animal. Attempts were made to breed from these mice with induced mammary cancer, to see if the disease was transmissible, unfortunately without success. Work on somewhat similar lines is being pursued at Newcastle by Pybus and Miller, who are following up the extraordinarily interesting discoveries of Strong in the United States. Strong reported that the methylcholanthrene treatment of certain inbred strains of mice induced a greatly increased tendency to carcinoma, particularly of the stomach, which was transmitted to subsequent generations without any further application of the methylcholanthrene.

Advances in radiology have been on several lines, but chiefly in developments of the complicated, but immensely important, task of assessing the distribution of dosage of X-rays and γ-rays in the body of

the patient in three dimensions. By means of small condenser chambers the dosage can now be measured directly in the patient during treatment, and studies are being made of the measurement of the integral dose and of the causes of X-ray sickness. Artificial radioactive substances such as radio-sodium and radio-phosphorus are being used for tracer element experiments and for radiotherapy. At the Strangeways Laboratory, Cambridge, the action of X-rays, γ-rays and α-rays have been studied in a large variety of materials ranging from inorganic substances, through *in vitro* culture of fibroblasts, to the normal brain of mice and rabbits.

At Leeds, Rudall has examined with X-rays the crystallographic structure of the proteins in the cells of the epidermis before and after cancerization, and finds that the proteins of papilloma tissues induced in rabbits by the Shope virus differ structurally from the proteins of normal skin.

The number of compounds which have been tested for chemotherapy in cancer must now run well into the thousands, and the present situation is that Haddow finds derivatives of 4-aminostilbene the most effective against transplantable tumours in rats; œstrogens are being used for prostatic human cancer and urethane for human leukæmia. It must be noted that all three compounds are also cancer-producing agents; for example, 4-dimethylaminostilbene evokes a wide variety of tumours in the rat, and urethane produces lung adenoma in mice. Œstrogens, while only weakly carcinogenic at the site of administration, produce uterine fibromata in the guinea pig (Lipschutz) and also facilitate cancer of numerous organs and tissues in mice of strains liable to spontaneous mammary cancer (W. U. Gardener). These findings reinforce Haddow's original theory that carcinogenicity and tumour-inhibitory capacity are closely linked properties of chemical compounds, somewhat in the same way that radiations in different dosages can either produce or inhibit the growth of tumours.

Koller has continued his cytological studies of the mechanism of radiotherapy and comes to the conclusion that the success of the treatment depends largely on the indirect action of the radiation, that is, upon the still healthy tissue forming the tumour bed, rather than a lethal action upon the tumour cells directly.

At the Cancer Research Laboratories of the Hebrew University, Jerusalem, detailed studies are being made of the malignant conversion of normal fibroblasts *in vitro* by the Rous agent, and on the cytology of the different strains of rat sarcomas *in vitro*, which present a great variety of structural peculiarities, although they were obtained by the same agent, namely, benzpyrene.

Prof. and Mrs. Kennaway, continuing their examination of that treasury of information, the Registrar-General's reports on the deaths in Great Britain, have extracted the facts that cancer of the scrotum is about twenty times less common in men of the highest social class than it is in the general population. Thus hygienic habits of cleanliness, and perhaps other conditions common in the wealthiest social strata, could, if spread over society in general, greatly diminish at least one form of cancer.

Cornelia Hoch-Ligeti has been confirming earlier results showing that milk added to the diet of rats receiving butter yellow (dimethylaminoazobenzene) gives considerable protection against the formation of liver tumours. It is therefore possible that dietary deficiencies may partly account for the widespread occurrence of liver cancer in the Japanese, Chinese, Indian and allied Asiatic races, and particularly the Bantus of South Africa, all of whom have been, until recently, less well nourished than Europeans.

Hieger, after ten years work on carcinogenic substances in human tissues (first discovered by Schabad in Leningrad), concludes that: (*a*) not only liver but also lung, kidney and muscle contain these substances; (*b*) human subjects that have died of cancer *or* of other diseases contain these agents; and (*c*) that they are to be found in the cholesterol-rich fraction of the tissues and are probably sterols or closely associated compounds.

OBITUARIES

Prof. F. Paschen

Prof. F. Paschen died in Potsdam on February 26; he was eighty-two years old. According to his daughter, the extreme cold at the time resulted in his contracting pneumonia, from which he failed to recover.

Paschen was a giant among spectroscopists, and with his passing there closes a chapter in classical spectroscopy which included such other names as those of Lockyer, Kayser and Fowler. It is difficult to realize that fifty-five years have passed since Paschen first began his classical work on the infra-red. Since then a veritable torrent of publication came from his pen, and only ceased with his death. He covered the whole of experimental spectroscopy in a masterly manner, making a succession of important discoveries. Infra-red measurements, precision wave-length determinations, analysis of series, interpretation of hyperfine structures, were all illuminated by him.

He developed the delicate Paschen galvanometer, discovered the Paschen infra-red series in hydrogen, was senior co-discoverer of the Paschen–Back effect in magneto-optics, invented the Paschen hollow cathode discharge and so on. His masterly analysis of the complicated series in the neon spectrum is a classic. Although the analysis of series in spectra was his major interest, yet he realized the value of the hollow cathode for hyperfine structure studies and did a great deal of work in this field too.

It was my good fortune to go to Berlin to study under Paschen in 1931, and he welcomed me as his first (and last) research student from England since 1914. My most vivid recollection is of a man with a dynamic virility, a freshness of mind and a generous nature. He had a profound understanding of most of the techniques of experimental spectroscopy, and it was an inspiration to see the energetic, impulsive manner in which he worked. His eyesight was unusually keen and he missed nothing. Withal he was an engaging *raconteur*, telling his amusing stories about physicists equally well in English and German. The Zeeman pictures he obtained will be surpassed only with difficulty, and he had a fund of knowledge on the use of high-resolution interferometers. He was essentially an exact experimenter, with little use either for gadgets or for those statistical methods which attempt to extract as much as possible out of observational data. In 1931 I showed him a trivial statistical trick I had developed. His smiling comment was: "If measurements on a plate are not self-consistent, smash the plate and take another. This is far better than statistics." A rash procedure

possibly, yet typical of the man, whose first aim was self-consistency and internal checking in all he attempted. Yet he was bold and adventurous in interpretation, with a masterly grasp over complexity. He had a deep respect for A. Fowler, who went to the other extreme and was hesitating and cautious. Paschen admired this caution and once remarked: "Fowler has never yet made a mistake". He confided to me that independently and simultaneously with Fowler he had arrived at the important analysis of carbon and silicon which showed the existence of multiple ionization spectra. Fowler's classic paper on this appeared first, and Paschen considered it was so much better than his work that he tore up his own manuscript. This was typical, for Paschen was the last man to take even due credit for himself, and was scrupulously just in apportioning credit and priorities to others.

Until the advent of Hitler, Paschen was president of the Physikalisch Technische Reichsanstalt; in 1933 he was dismissed by the Nazis and replaced by Stark. He had made himself highly unpopular with the Nazis by persistently purchasing considerable costly spectroscopic equipment from England, maintaining that German makers could not equal the British products. After 1933 he was permitted to use a small room in the Reichsanstalt. He strongly disliked the Nazis and their methods; but possibly his age saved him. He wrote me an open denunciatory letter in 1936, which if intercepted must surely have led him to the concentration camp. Between 1933 and 1939 his time was largely devoted to measuring old plates, and a few papers were published. In 1943 he lost all his possessions in a fire raid, but although seventy-eight years of age still kept on working, and to the last was engaged on calculations.

He had many pupils and has trained a whole generation of spectroscopists who have much to thank him for, particularly in Germany and in the United States. S. TOLANSKY

The Right Hon. Sir Halford Mackinder, P.C.

BORN at Gainsborough on February 15, 1861, Halford John Mackinder was the son of a medical practitioner and received his school education at Epsom College, whence he proceeded to Christ Church, Oxford, becoming president of the Oxford Union in 1883.

It is not clear what turned Mackinder's attention in his student days to geography, which was then a subject unknown in the universities and despised by schools, but it was almost immediately after graduation that he planned a series of lectures under the title of "The New Geography" for the Oxford University Extension Lectures. His ideas he crystallized into a paper on "The Scope and Methods of Geography" which he read before the Royal Geographical Society in 1887. It was through the interest created in the Council of the Society that the University of Oxford appointed Mackinder in the same year to a readership in geography, the only previous holder of such a post having been Richard Hakluyt in the reign of Queen Elizabeth.

Although called to the Bar in 1886, Mackinder devoted himself to university work. He became a Student of Christ Church, Oxford, in 1892, and in the same year was appointed principal of University College, Reading, now the University of Reading.

While holding those posts he became president in 1895 of Section E (Geography) of the British Association for the Advancement of Science, and put forward a powerful plea for the formation of a university institute of geography, where might be brought together what we now call 'physical' and 'human' geography on the same platform. It is again to the credit of the University of Oxford that the School of Geography there was created in 1899.

Mackinder lived to see his great aims for the university teaching of modern geography realized by the creation of honours schools in nearly all the universities of Great Britain, and there is no doubt that the part he himself played was an extremely important one.

Although he continued as reader in geography at Oxford until 1905, in 1903 he left Reading to become director of the London School of Economics and Political Science. The School was then only eight years old, and Mackinder succeeded Prof. W. A. S. Hewins. It is well known that the School was founded by a group of Socialists headed by Mr. and Mrs. Sidney Webb and Bernard Shaw; but its founders realized the danger of allowing party political views to dominate the activities of a young institution the sphere of work of which was, and is, a dispassionate academic study of economics, politics and the social sciences generally. Mackinder was already known for his Liberal–Unionist political views (he had contested Warwick as a Liberal in 1900), and his choice as director of the School supplied a valuable balancing influence and removed once and for all what might have been a real danger.

In 1909, at the age of forty-eight, Mackinder entered his political career by standing as Unionist candidate for Hawick Burghs. Though not successful in this attempt, in the following year he was elected for the Camlachie Division of Glasgow, a seat which he retained until 1922. He relinquished his post as director of the London School of Economics in 1908 but remained as reader in geography at the School (a post he had held part-time since 1900), later as professor, until 1925, serving under Pember Reeves and Sir William (now Lord) Beveridge as successive directors.

In 1920 Mackinder took charge of a special temporary mission as British High Commissioner for South Russia, at the completion of which he was knighted. After his retirement from academic work he served as a member of the Royal Commission on Food Prices in 1925, and in the following year was made a Privy Councillor, and became chairman of the Imperial Economic Committee. He was already chairman of the Imperial Shipping Committee, a post which he held from 1920, the year of its formation, until 1945.

It is difficult to assess the whole influence of Mackinder on the development of geographical thought. Although what he initiated and taught at Oxford, Reading and London has become absorbed as an essential part of geography as it is now studied throughout the universities of Britain, his ideas were often so in advance of those of his political contemporaries that they are only now coming to be appreciated. His most famous work, "Britain and the British Seas", appeared in 1902. It is rightly described as a classic. For the first time it related the physical features of our own familiar land with the sequence of human occupation and development and with our economic interests. In lucidity of language which is used to clothe the thoughts of a clear and brilliant brain, it has never been surpassed. His masterly analysis of the factors of position is only

now being appreciated in connexion with the development of world airways; his concept of regional contrasts, especially between Highland Britain and Lowland Britain, or between Metropolitan England and rural areas, is only now being recognized by the development of physical planning on a regional basis so that contrasts in needs and aims can receive adequate consideration in practice. The problems of Highland Scotland, to take an extreme example, are difficult of comprehension in Metropolitan England. Mackinder made free use of diagrammatic maps or cartograms, on which selected facts only are represented, to drive home his points—this is an art well known to geographers but still relatively unfamiliar to the public.

His deservedly popular lectures exercised a great influence on the many thousands of students who crowded to hear him. Though delivered without notes, they showed his dislike of slipshod work: they were balanced, closely reasoned and inevitably closely allied to the series of sketch maps which always adorned the walls when he was lecturing.

Although he worked steadily among his parliamentary colleagues to secure an appreciation of geographical analysis, he was still in advance of his time when he published "Democratic Ideals and Reality" in 1919. It aroused interest, but not enough; and it was left to the Nazis to prostitute geography to their ideology in the school of Geopolitik. It was only during the Second World War that this remarkable work of Mackinder's began to be appreciated. The original edition was still in print when the book was re-issued in a popular form. Most great problems of the day need analysis from economic, political, sociological, historical and geographical points of view: too often wrong conclusions are reached through the neglect of one of these points of view, and the most neglected approach is still that of the geographical. In this sense Mackinder's work has still to bear its full fruit. His outstanding contributions to geographical thought were recognized towards the close of his long life by the highest award the Royal Geographical Society has power to bestow—the Patron's Medal; and the highest award of the American Geographical Society, the Charles P. Daly Medal, was presented to him in 1944.

It is not widely known that Sir Halford was a mountaineer of the first calibre. In 1899, with the help of two Swiss guides, he was the first to ascend Mount Kenya, and it was thirty years before another climber succeeded in making what is still regarded as a very difficult ascent.

He retained his brilliant intellect until the end, inconvenienced only by increasing deafness, and only a few months before his death on March 6, 1947, he had visited his old Department at the School of Economics and discussed problems with his former colleagues and students. L. DUDLEY STAMP

Sir Ali Ibrahim Pasha, K.B.E.

THE death of Sir Ali Ibrahim Pasha, of Cairo, removes the greatest personality in the medical profession of the Middle East. Sir Ali's career was a model of what perseverance and study can do.

Born in 1880, he graduated from the Cairo School of Medicine in 1901. After holding a house appointment in the famous Kasr el Aini Hospital of Cairo, he began his career as a young assistant surgeon in the provincial hospitals of Upper Egypt. Within a few years his skill as a surgeon, his personality as a humane doctor and a very pleasant colleague made his name popular and well known in many Mudiriahs of Upper Egypt.

He was then recalled (in 1907) to take up an appointment as assistant surgeon at his old hospital, the Kasr el Aini. Again his charming personality, his diagnostic acumen and surgical skill soon made him the recognized surgeon in Cairo and later in the whole of Egypt.

He became dean of the Faculty of Medicine in 1928, and took an active part in the reorganisation of medical teaching, and in the draughting and execution of a huge programme of construction and equipment of the Departments of the Faculty and the teaching hospitals. In fact, his term of office as dean from 1928 until 1940 may be considered a period of renaissance in the history of medical education in Egypt.

Ali Pasha's activities extended far beyond the boundaries of a Faculty. He instituted and organised the Royal Egyptian Medical Association on the lines of the British Medical Association. That Association now has an imposing building of its own in Cairo, with a big ceremonial hall, a library, a museum, and it issues a medical journal.

Ali Pasha was an active member and later president of the Egyptian Red Cross Society.

He was instrumental in his short career as Minister of Health in passing through Parliament a Bill creating a Syndicate of the Medical Profession to look after the interests of the profession and to provide funds for an insurance scheme.

During the last six years Ali Pasha was rector of the Fouad I University of Cairo, when his constructive genius was again most productive and his powers of organisation were most evident.

His death at the age of sixty-six was certainly a great loss to the medical profession and to the whole of Egypt. I. S.

Major M. Connolly

MATTHEW WILLIAM KEMBLE CONNOLLY was born in Bath on February 13, 1872, the son of Vice-Admiral Matthew Connolly, R.N., and Harriet Connolly, *née* Kemble. He was educated at Haileybury and Sandhurst, and for some years led the life of the Army officer of his period. He married Muriel Vernon, of Clontarf Castle, Dublin, who, with their one son, survives him.

After retiring from the Army, Major Connolly became an unofficial scientific worker in the Department of Zoology of the British Museum. He was especially interested in the Mollusca, particularly the land and freshwater molluscs of Africa, of which he had profound knowledge and on which he was the leading authority. Many papers on this subject were published from 1910 onwards: the most important was, undoubtedly, "A Monographic Survey of South African Non-marine Mollusca" (*Ann. S. Africa Mus.*, **33**, 1–660, pls. 1–19; 1939).

In later life Connolly was badly crippled by arthritis and could walk only with difficulty. Despite this handicap, he insisted on doing everything himself; indeed, I had known him for more than twenty years before he would let me walk across Cromwell Road with him, and even then only because the fog was thick and the crossing more than usually dangerous. Inside the Museum he went from room to

room, and from library to library with cheerful good humour.

Connolly joined the Malacological Society of London in 1908. Five years later, in 1913, he joined the Conchological Society, becoming its president for the session 1929–30; at the time of his death he was a vice-president. He was no narrow-minded specialist; his interests were wide, his knowledge of cookery and wines extensive. He remained in London for most, if not all, of the war years, and was among the survivors when his hotel was largely destroyed by a flying bomb. That incident affected him more than he cared to admit: soon after the end of hostilities, he began to wind up his affairs in London in order to retire to Bath. This last plan was never realized; he died in South Kensington on February 26, 1947, and is buried in the family vault at Bath.

A. T. Hopwood

NEWS and VIEWS

Sir Roy Robinson, O.B.E.

It has been announced that Sir Roy Robinson will shortly relinquish his appointment as director-general of forestry. This will not, of course, mean that he is severing his official connexion with the forest administration of Great Britain, for he will remain chairman of the Forestry Commission, a post he has occupied since 1932. Sir Roy has been a member of the Commission ever since it was set up in 1919 on the recommendation of the Acland Report, in the preparation of which he himself took an important part. The adoption of that report marked a new era in British forestry, constituting the recognition, forced by the experiences of the First World War, that the State must accept responsibility for remedying the very unsatisfactory position in the matter of forests and timber supplies, with an inadequate area of forests and a very low production per acre. For some years he was the only professionally qualified forester on the Commission.

On a recent occasion, the Society of Foresters of Great Britain met to present to Sir Roy its medal in recognition of his distinguished services to forestry, services which incidentally have not been confined to Britain, for he has also taken a very active part in all four Empire Forest Conferences, presiding over the last one, held in 1935 in South Africa. In accepting the medal, he reviewed the work accomplished by the Commission, particularly during the difficult times when it was threatened with complete stoppage, and showed how almost all the arguments used against its activities and plans had later proved wrong. The Commission's 1943 Report on Post-war Forest Policy has been acknowledged in all quarters to be a very able document, though naturally enough all its proposals do not please everyone. It has been accepted by Parliament with only minor amendments as the basis of further work; it will probably come to be known as the Robinson Report, and form a landmark second only to the Acland Report. In the latest published annual report covering the year 1944–45, the total area of plantation is shown as closely approximating half a million acres, apart from another 150,000 acres on private or local authorities' lands in respect of which grants were paid. It is indeed a great achievement for twenty-five years, but only a step on the way, for Sir Roy has set us a new target—two million acres within the next fifty years—and urges that no excuses should be accepted for reducing or postponing it.

Royal Geographical Society Awards

His Majesty the King has approved the award of the Royal Medals of the Royal Geographical Society as follows:

Founder's Medal: Brigadier Martin Hotine, director of Colonial Surveys, for his original research work in air survey, his contributions to the geodesy of Great Britain and Africa, and for his cartographic work during the Second World War; *Patron's Medal:* Colonel Daniel van der Meulen, for his exploratory journeys in the Hadhramaut in 1931 and 1939, and his contributions to the geography, archæology and ethnography of Southern Arabia.

The Council of the Society has made the following awards:

Victoria Medal: Prof. E. G. R. Taylor, emeritus professor of geography in the University of London, for her contributions to the advancement of geographical knowledge, including the study of the geographical distribution of population and industry, the promotion of a National Atlas for Britain, and her studies in the development of geographical thought; *Murchison Grant:* Mr. Gordon Manley, for his observations on the meteorology of East Greenland and his research into mountain climates and snow cover in Britain; *Back Grant:* Lieut.-Colonel Andrew Croft, for his journeys in the Arctic, especially as second-in-command of the Oxford University Expedition to Spitsbergen, 1938, and in connexion with Exercise Muskox, 1946; *Cuthbert Peek Grant, 1946:* Mr. John Wright, for his survey work on expeditions to Iceland, Spitsbergen and Ellesmere Island, and in the Sudan during the War; *Cuthbert Peek Grant, 1947:* M. André Guibaut, for his exploration of the Salween gorges, Burma, 1936–37, and of the upper Tung valley on the Chinese–Tibetan borderland, 1940; *Gill Memorial, 1947:* Commander K. St. B. Collins, for bathymetric surveys between Scotland and Iceland and in Denmark Strait under enemy attack.

United Nations Educational, Scientific and Cultural Organisation: United Kingdom Committee

Mr. George Tomlinson, Minister of Education, has appointed the following committee to consult with him, in the widest possible terms, on all matters affecting the United Nations Educational, Scientific and Cultural Organisation: Mr. Tomlinson (chairman), Sir Ronald Adam, chairman, British Council; Dr. W. P. Alexander, secretary, Association of Education Committees; Prof. P. M. S. Blackett, University of Manchester; Mr. R. S. Brownell, secretary, Ministry of Education, Northern Ireland; Mr. R. A. Butler, M.P.; Mr. R. Gould, general secretary, National Union of Teachers; Mr. D. R. Hardman, Parliamentary Secretary to the Ministry of Education; Dr. W. A. F. Hepburn (Scotland); Sir John Maud, secretary, Ministry of Education; Dr. H. W. Meikle (Scotland); Sir Philip Morris, vice-chancellor, University of Bristol; Dr. Margaret Read, head of the Colonial Department, Institute of Education, Univers-

ity of London; Sir Ernest Pooley, chairman, Arts Council of Great Britain; Mr. J. B. Priestley; Sir Robert Robinson, president, Royal Society; Mr. B. B. Thomas, secretary of Welsh Department, Ministry of Education; Mr. W. E. F. Ward, Colonial Office, with Mr. F. R. Cowell, assistant secretary, Ministry of Education, as secretary.

Besides this committee, nine national co-operating bodies have already been established to cover the various specialized fields of the activities of the Organisation. Their main functions are to advise the United Kingdom delegates to the conferences of the Organisation and to assist in making known and carrying out projects adopted by it. Six of these are committees covering education, arts, mass communications, libraries, museums, and social sciences. The remaining three are organisations which have undertaken the functions of co-operating bodies; they are the Royal Society, for natural sciences; the British Academy, for letters and philosophy; and the Royal Institute of British Architects, for architecture and planning.

Atomic Survey

THE Atomic Scientists' Association has issued a pamphlet entitled "Atomic Survey", which is a short guide to the scientific and political problems of atomic energy. The authors are Prof. P. B. Moon, secretary of the Association (Physics Dept., The University, Birmingham), and Dr. E. H. S. Burhop, both of whom are well-known nuclear physicists, and have been engaged on the atomic bomb project. In the preface, which is contributed by Prof. R. E. Peierls, it is pointed out that the subject of atomic energy is of great topical interest and importance and that many people, quite rightly, hold strong views on the proper use of this source of power. Strong views should be based on accurate information, and although it requires an expert to understand all the technical details, it is possible to present the essential facts of atomic energy in simple language so that even the non-expert may grasp them. This the pamphlet does admirably. In its thirty-two pages, divided into fourteen brief sections, there is little, if any, information which has not already appeared elsewhere; but this is probably the first time that it has been collected together into a connected and concise form. The section headings —the elements; radioactivity and nuclear reactions; the chain reaction pile; pile problems and prospects; separation of uranium 235 from mixed uranium; the physical effects and defence against the atomic bomb; the constructive application of, and military strategic significance of, atomic energy; the British atomic energy programme; the scientist and atomic energy; the control of atomic energy; and the immediate steps to ease the tension caused by the atomic bomb—are an excellent guide to the matters discussed.

"There is not and is unlikely to be any specific defence against the atomic bomb" makes it abundantly clear, the pamphlet emphasizes, that our first major task is to solve the political problem of ensuring that atomic energy shall not be used for the obliteration of mankind. Then, and only then, can scientific men devote their energy to the intense study of nuclear behaviour; to the extension of our knowledge of a subject, which the authors state with some authority is still incomplete in spite of the spectacular advances of the last decade; and to the development of constructive applications of atomic energy.

Atomic Energy Utilization in Britain

THE Atomic Energy Production headquarters of the Ministry of Supply at Risley, near Warrington, is increasing its team of design and planning engineers, to speed up the development of atomic research in Britain. Already a large technical department at Risley is planning the factories, such as the one being erected at Springfields, Lancashire, which are required for the production of fissile material. This factory, one of the war-time chemical defence plants, is being converted by the Ministry of Supply into an atomic energy centre for the manufacture of uranium metal. The processes to be carried out will consist of the refining of pitchblende concentrates, reduction to metal and the machining and finishing of uranium metal rods for atomic piles. It is hoped that building work and plant erection will be sufficiently advanced for production to begin in the late autumn. When production reaches its peak, a labour force of more than a thousand will be required, of which a number will work on continuous shifts. Most of these will be recruited locally, but it will also be necessary to bring in supervisory staff with specialized knowledge.

Gordon's Astrolabe at the Royal Scottish Museum

THE executors of the late Mrs. Florence Cumming, 18, Ainslie Place, Edinburgh, have handed over to the Royal Scottish Museum an astrolabe which at one time belonged to Robert Gordon of Straloch, the famous Scottish geographer. Robert Gordon of Straloch was born in Aberdeenshire in 1580 and died in 1661. He studied at Aberdeen and Paris, to which latter city he went at the age of eighteen. When he first became interested in cartography is not known, but his later work brought him fame as one of the great map-makers of Scotland. At the request of Charles I, he prepared an atlas of Scotland, which was published at Amsterdam in 1648; and it is recorded that two years later he published in the same city a second atlas of Scotland, called "Theatrum Scotiæ", which he dedicated to Oliver Cromwell—possibly the same atlas with revised title to suit the changed circumstances. Gordon is particularly noted for his revision of Timothy Pont's maps of Scotland and Blaeu's Great Atlas of the World, published in Amsterdam in 1654, a wonderful atlas in eleven large folio volumes, of which volume six contains the maps of Scotland.

Gordon's astrolabe is an interesting and most decorative relic, typical of the European version of this ancient eastern instrument. On its edge is inscribed, "Robertus Gordonius"; the instrument was probably acquired by him before proceeding to Paris, or in Paris itself. His pride of possession can well be understood, and it would be natural that the date, 1597, should be inscribed on the newly acquired treasure. The early form of the numerals on the scales, however, would suggest that the instrument was made at least a hundred years earlier than the inscribed date. The astrolabe was the universal instrument and calculator of astronomers, astrologers, travellers, and navigators from the seventh to the eighteenth century. For over a thousand years it maintained a remarkable consistency in design, and the art of its use and construction became known in almost every civilized country. Gordon's astrolabe may be seen in the main hall of the Royal Scottish Museum, Edinburgh, where it is being temporarily shown before being incorporated in the Science Gallery collection.

Industrial Research in Scotland

THE Federation of British Industries has arranged a one-day conference to be held in the Merchant's Hall, Glasgow, on Friday, April 25. Mr. Alexander Johnston, chairman of the Scottish Regional Council of the Federation, will preside at the morning session, when Sir James Lithgow will give the opening address. Papers on research in Scotland's major industries will be read by Mr. W. Barr (on steel), Sir Wilfrid Ayre (on shipbuilding), and Mr. W. G. Marskell (on heavy engineering). The chairman of the afternoon session will be Prof. T. Alty, of the University of Glasgow, and the following five papers will be given: research as a means of providing new industries, by Dr. J. W. McDavid; chemical research for Scottish industry, by Prof. W. M. Cumming (Royal Technical College, Glasgow); Scotland's mineral raw materials, by Mr. T. H. Whitehead (Geological Survey of Great Britain); research in the light engineering industries, by Mr. J. N. Toothill; the individual Scottish firm and its application of research, by Prof. R. Hay (Royal Technical College, Glasgow). Sir Steven Bilsland, chairman of the Scottish Council, will sum up the discussion and addresses. Admission to the Conference is free, and tickets can be obtained either from the F.B.I. Scottish Office, 142, St. Vincent Street, Glasgow, C.2, or from the F.B.I. Industrial Research Secretariat, 21, Tothill Street, London, S.W.1.

Acoustics Group of the Physical Society

THE Acoustics Group of the Physical Society has been formed at an inaugural meeting held at the Royal Institute of British Architects. Mr. H. L. Kirke was in the chair and Dr. Alex Wood gave an address entitled "The Contribution of Acoustical Science to Allied Studies". The meeting was attended by some 170 persons. The principal object of the Group is to provide an opportunity for the very varied types of workers engaged on acoustical problems to meet and discuss the scientific and technical implications of their work. The officers and committee of the Group, elected at the inaugural meeting to serve for the year 1947–48, are as follows: *Chairman:* Mr. H. L. Kirke; *Vice-Chairman:* Dr. A. Wood; *Joint Secretaries:* Messrs. W. A. Allen and A. T. Pickles; *Committee:* Messrs. H. Bagenal, R. S. Dadson, Dr. C. S. Hallpike, J. McLaren, B. C. Sewell, W. West, Dr. A. B. Wood and Dr. W. Greenhouse Allt. Membership of the Group is open both to members and also to non-members of the Physical Society. It is hoped to arrange for some six meetings a year, including at least one special summer meeting, which will take the form of a symposium covering a particular aspect of acoustical investigation; reprints of papers will be circulated to members when available, and it is hoped to arrange for research panels on special topics. For further particulars application should be made to the Joint Honorary Secretaries, at the Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.

Announcements

PROF. F. J. M. STRATTON, professor of astrophysics in the University of Cambridge, and Prof. A. Dauvillier, of the École supérieure d'Électricité, have been elected *Correspondants* for the Section of Astronomy, and Prof. P. M. S. Blackett, Langworthy professor of physics in the University of Manchester, and Prof. Emile Henriot, professor of physics in the University of Brussels, have been elected *Correspondants* for the Section of General Physics, of the Paris Academy of Sciences.

THE Holweck Prize for 1947 of the Physical Society and the Medaille Holweck of the Société Française de Physique have been awarded to Prof. E. N. da C. Andrade, Quain professor of physics in the University of London, in recognition of his experimental investigations on the solid and liquid states.

MR. A. J. PHILPOT, director of the British Scientific Instrument Research Association, has been appointed director of the Scientific Instrument Manufacturers' Association of Great Britain, Ltd. He will continue as director of the Research Association, and will work from the Association's offices at 26 Russell Square, London, W.C.1. Mr. Philpot will speak on "Scientific Instrument Manufacture and the Nation" at the Northampton Polytechnic, London, E.C.1, on April 24 at 7.30 p.m.; admission is free, by ticket obtainable from the Polytechnic.

DR. J. L. B. SMITH, for many years in charge of organic chemistry at Rhodes University College, Grahamstown, has recently resigned to be appointed research professor in ichthyology in the College. Dr. Smith is already well known for his ichthyological researches, which included the announcement in 1939 of the discovery of a living Cœlacanthid fish (see *Nature*, **143**, 455; 1939). Dr. Smith has also been awarded a research fellowship in ichthyology by the South African Council of Scientific and Industrial Research.

MR. W. L. HALL has been appointed chief officer of the Liaison Department of the British Non-Ferrous Metals Research Association, in succession to Mr. W. C. F. Hessenberg, who has been appointed head of the Mechanical Working Division of the British Iron and Steel Research Association. Mr. Hall graduated from the Royal School of Mines with a first-class honours degree in 1936. After two years experience in a steel works, he joined the research staff of the British Non-Ferrous Metals Research Association in 1938, working on galvanizing, stress corrosion of light alloys and the properties of aluminium–magnesium alloys; he was transferred to the Liaison Department in 1944.

SIR WALLACE AKERS, a director of Imperial Chemical Industries, Ltd., will deliver the May lecture of the Institute of Metals on May 21 at 6 p.m.; he will speak on "Metallurgical Problems involved in the Generation of Useful Power from Atomic Energy". Admission is by ticket obtainable from the Institute.

THE Council of the Royal Society will shortly consider the nomination of not more than three marine biologists to visit the Roscoff Biological Station (Finistère) during the summer months. Those wishing to be considered in this connexion should communicate with the Assistant Secretary of the Royal Society, Burlington House, London, W.1, not later than May 7, and should submit a brief statement of the investigation which it is proposed to carry out, together with an indication of the inclusive dates of the visit.

A ONE-DAY school on atomic energy for journalists arranged by the Atomic Scientists Association will be held in the Embryology Theatre, University College, Gower Street, W.C.1, on April 26, 1947. The speakers will be Prof. H. S. W. Massey, Prof. M. H. L. Pryce and Prof. R. E. Peierls.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Structure of Fibrous Keratin

THE generally accepted model of the structure of keratin proposed by Astbury and Bell[1] is based first on the crystallographic data obtained from X-ray studies on *whole* wool fibre, and secondly upon the interpretation of experiments on *whole* fibre extension in water, that is, 100 per cent elongation indicates a complete unfolding of α-keratin polypeptide chains[2]. Electron microscopic studies[3] have demonstrated conclusively that the cortex of wool fibre is composed of two distinct components, fibrils and matrix, that the amorphous matrix is capable of considerable elongation, and that the sub-cellular fibril, which is the component responsible for the X-ray fibre pattern, may undergo extension considerably in excess of 100 per cent without rupture. New electron microscopical evidence throws additional doubt on the picture of molecular chains extended parallel to the fibre axis, and a revision of the structural conclusions seems now desirable.

Astbury and Street[4] early pointed out that all X-ray fibre patterns from wool have diffuse haloes superimposed. These do not correspond to disoriented fibrils; by precise microphotometry of the patterns and separation of that part comprising diffuse haloes, we have been able to show that the latter correspond to the truly amorphous part of the wool fibre, namely, the matrix, the diffraction pattern from which gives the same angular distribution of scattered intensity. Preparations of matrix, obtained by partial solution of the cortical cells by mild chemical treatments, give the same pattern also, which leads us to believe that the matrix consists simply of keratin molecules showing little tendency to order. These findings are confirmed by electron micrographs of matrix material (Fig. 1), obtained by the gold-shadowing technique of Williams and Wyckoff[5], showing an aggregate of particles (keratin molecules) of average diameter 102 A.

From shadow-length measurement, the molecules appear to be approximately isometric. Assuming the density to be the same as the bulk density and that the particles are spherical, the molecular weight is calculated to be 360,000. Moreover, the fibrils (1000–2000 A. wide) show further subdivision into proto-fibrils of fairly uniform size (100 A. wide by 2000 A. long); these appear to be the ultimate fibrous units and may correspond to the micelles postulated by Speakman[6] on the basis of other work. These pro ofibrils are often found twisted about the axis of the fibril, giving a rope-like appearance which may account, in part at least, for the angular dispersion of the X-ray reflexions. These two features are evident in Fig. 2.

Owing to the increase in contrast arising from the gold-shadowing, the protofibrils show a further significant structure,

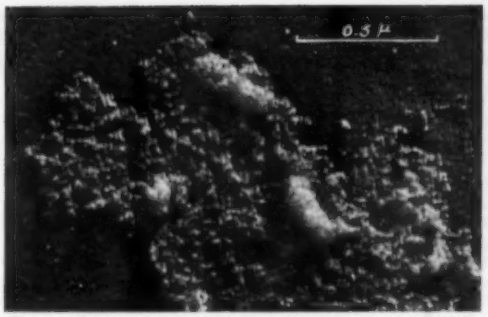

Fig. 1. GOLD-SHADOWED ELECTRON MICROGRAPHS OF KERATIN MOLECULES COMPRISING MATRIX MATERIAL FROM WOOL FIBRE. CALCULATED THICKNESS OF GOLD FILM, 9 A.

namely, a series of particles of uniform size along their length (Fig. 2). From a large number of measurements of the spacing of these along the protofibril, the average particle diameter is found to be 110 A., and it is concluded that these do, in fact, represent the keratin molecules (as in Fig. 1) linked together to give the uni-dimensional crystals. It is further significant that this spacing corresponds to the feather-keratin fibre period obtained by low-angle X-ray scattering, found by Bear[7] to be 95 A., and to half the porcupine quill keratin period, found by MacArthur[8] to be 198 A.

That these new features are real and not artefact is confirmed by the following. (i) They have the dimensions, within the limit of experimental error of measurement, of the particles of dispersed keratin matrix. (ii) In the background structure, usually assumed to arise from the molecules of cellulose nitrate in the supporting film, the particles have an average size of less than 90 A. This interpretation is supported by the observation by Boyer and Heidenreich[9] of such structure by direct electron microscopy (that is, without metal shadowing) of ethyl cellulose films. (iii) At fibril extremities these particles may be frequently observed in the process of splitting off the proto-fibril. (iv) The dimensions of the particles of the background vary with the nature of the supporting film (for example, polyvinyl, formal and polystyrene films show different particle sizes), whereas the spots on the fibrils remain the same.

We suggest, therefore, that the keratin molecule is a well-ordered discrete unit somewhat similar to that postulated for the globular proteins[10], and that fibrous keratin does not consist of long extended, or even partly folded, chains, but of strings of globular

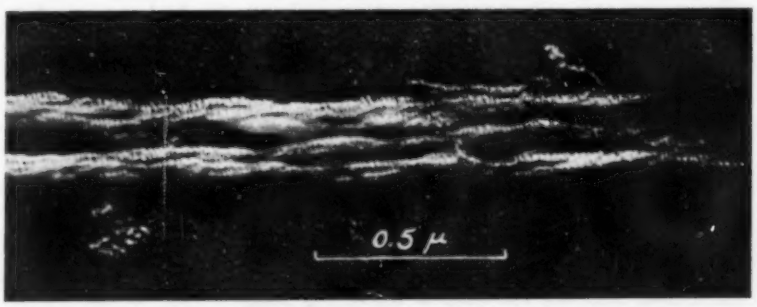

Fig. 2. GOLD-SHADOWED ELECTRON MICROGRAPHS OF FIBRILS ISOLATED FROM CORTICAL CELLS OF WOOL, INDICATING SUBDIVISION INTO PROTOFIBRILS AND SHOWING PARTICULATE STRUCTURE OF THESE. CALCULATED THICKNESS OF GOLD FILM, 9 A.

molecules. There is electron microscopical evidence that this may also be the case with other fibrous proteins[11]. Within each separate molecule the folding of the polypeptide chains must be much more extensive than the α-fold suggested by Astbury for the keratin-myosin group. This new model would not be inconsistent with the X-ray data on α-keratin. The β-keratin pattern cannot now arise from the complete unfolding of the polypeptide chain, but is more probably connected with the presence of inter-fold water. The importance of water in the $\alpha \rightleftharpoons \beta$ transformation has never been adequately explained by the earlier models.

A full account of this work will be published shortly.

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Formation of Coking Coal by Thermal Treatment of a Cannel Coal

GEOLOGICAL and petrographical investigations have shown that the residues of the higher plants and the microplants (*Ölalgen*) have both played a part in coal formation: coals formed from the former have been called *humus coals*, while those from the latter are known as *sapropelite coals*. According to G. Stadnikoff[1], the vitrain of the banded bituminous coals is of mixed origin, being formed from humus and the unsaturated fatty acids of the Algæ fats. The humus coals consist of bitumens and humus, and on dry distillation give primary tars which contain phenol: the sapropelite coals (bogheads and cannels) consist of fatty acids and their transformation products, and give primary tars, rich in paraffinic and naphthenic substances, but containing no phenols.

The X-ray examination of coals[2] has shown that coking coal bitumens consist of lamellar, polynuclear aromatic molecules which contain a small but critical proportion of oxygen. The inner diffraction halo of such coals shows a characteristic variation in half-peak width when the coal is subjected to increased temperature, passing through a more or less pronounced minimum value in the neighbourhood of 500–550°. The X-ray examination of some fifty or sixty bituminous coals and lignites has shown that this behaviour is characteristic of coking coals. If the average crystallite dimension along the *c* axis (calculated from the half-peak width of the inner (002) diffraction) is plotted against carbonizing temperature, the curve obtained shows a maximum in the neighbourhood of 550°. A north Staffordshire cannel coal (C, 86·38; H, 6·65 per cent: ash, 1·26; moisture, 1·15; volatile matter (ash free, dry), 44·8 per cent), although practically non-swelling (B.S. swelling No. 1–1½) has been found to give a *c*-dimension-carbonization temperature curve (Fig. 1) with a pronounced maximum at 550°. This cannel coal was exceptional in another respect: whereas the coal itself gave a powder photograph the microphotometer trace of which showed a symmetrical inner halo (Fig. 2*a*), after heating the coal in nitrogen to 400° at 5° per min., the inner halo then showed a pronounced asymmetry (Fig. 2*b*), which no longer

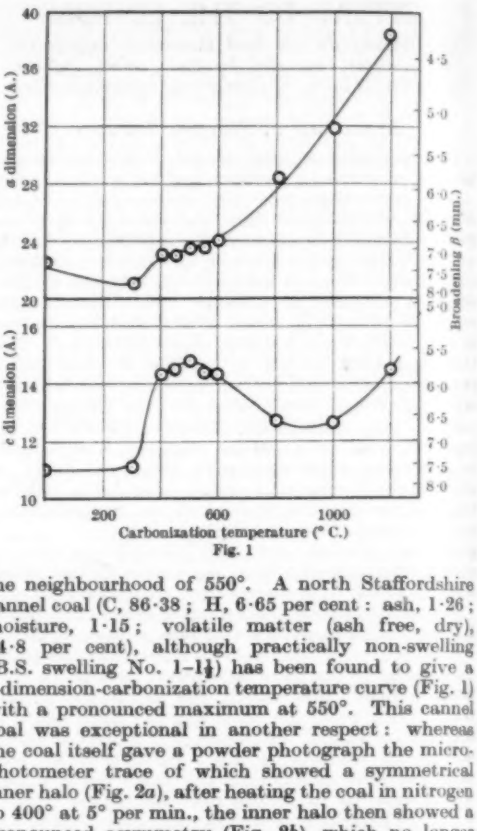


Fig. 1

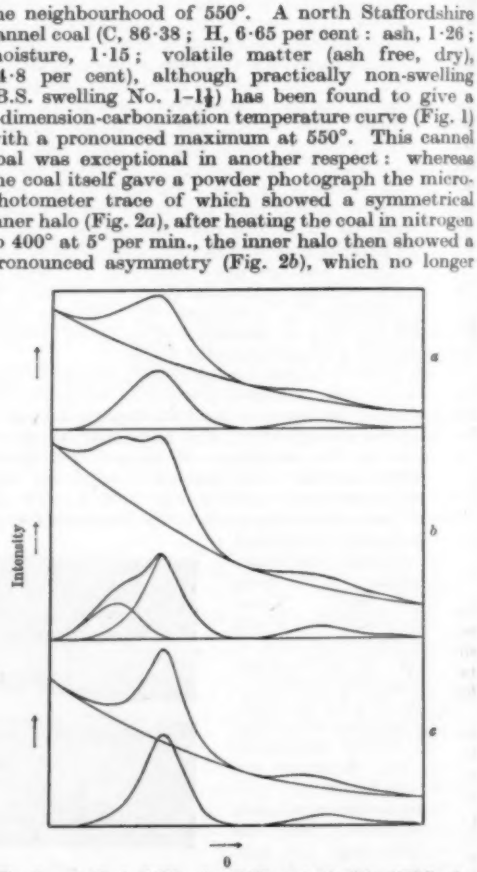
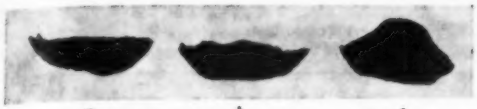


Fig. 2. *a*: Coal, *C* 921; *b*: *C* 921 carbonized to 400° C. at 5° per min.; *c*: *C* 921 carbonized to 450° C. at 5° per min.



a b c

Fig. 3

appeared in the powder photograph of the coal after heating to 450° at 5° per min. (Fig. 2c).

A probable explanation of these phenomena is that during the heating at 5° per min., some of the naphthenic or paraffinic bitumen in the cannel escapes volatilization and undergoes aromatization, being converted into the coking coal type of bitumen. This suggests that there should be a concomitant change in caking power. Fig. 3a shows the coke button obtained from the cannel in the B.S. crucible swelling test, that is, by heating rapidly 1 gm. of the finely powdered coal in a silica crucible over a bunsen burner; Fig. 3b is a photograph of the button obtained in the same test from a sample of the cannel which had been preheated to 350° at 5° per min.; and Fig. 3c is of the button from the cannel preheated to 400° at 5° per min. The increase in swelling property caused by thermal pretreatment is obvious, and is made even more striking by the fact that the preheating to 400° gave an agglomerated product (loss in weight, 16 per cent) which was recrushed to a powder before carrying out the crucible swelling test.

This result has a practical significance in that the British Standards crucible swelling test, which involves rapid heating, may give misleading results if the coal under examination contains an appreciable proportion of sapropelite material. The theory that the coking coal bitumens owe their origin to the thermal decomposition of sapropelite material does not appear to be tenable in view of the fact that cannel coal sometimes occurs as one of the banded constituents of bituminous coal seams.

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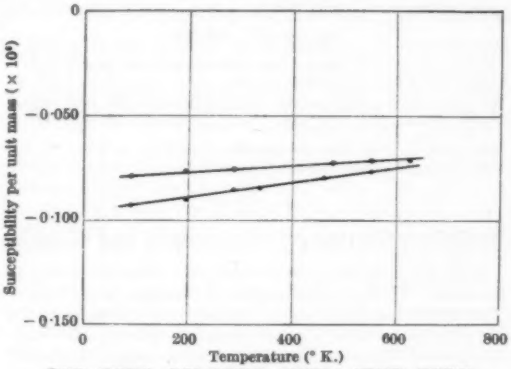
Temperature-Dependence of Magnetic Susceptibility of Annealed and Cold-worked Copper

Investigations recently carried out on the variation with temperature of the magnetic susceptibility of annealed and cold-worked copper have shown a different temperature-dependence in the two cases. A qualitative attempt is made to account for the difference on present theoretical lines.

The metal used was very pure 'H.S.' brand copper supplied by Johnson, Matthey and Co., Ltd., in the form of rods 15 cm. long and 5 mm. in diameter. The iron content was less than 0·005 per cent. A rod was first annealed for 10 hours in hydrogen at 950° C. and then either cooled slowly or 'quenched' in water. Both processes gave similar magnetic results, indicating that the specimens were free from ferrous impurity. In the case of the 'quenched' specimen, dissolved iron atoms should be retained in solution at room temperature, while slowly cooling the specimens should allow precipitation of the ferrous impurity.

The Gouy method and an electrodynamic balance[1] were used in the magnetic measurements. Determinations were made over the temperature range 90°–630° K. After a run had been taken with the annealed specimen, it was cold-worked by wire drawing, and its magnetic susceptibility measured over the same temperature range. Before measurement the specimen was allowed to recover for 24 hours[2]. The higher temperatures were not maintained for long periods and annealing did not take place. This was shown by the fact that the room temperature susceptibility value could be repeated afterwards.



Open circles, cold-worked copper; filled circles, 'quenched' copper

In the graph it is seen that the susceptibility varies linearly with temperature, the quenched specimen giving a 21 per cent change over the temperature-range as against a 12 per cent change in the case of the cold-worked specimen. Cold-working in the case shown was a 2·84 per cent reduction in diameter due to wire-drawing.

The reduction in numerical susceptibility in diamagnetic metals due to cold-working has been noted[3,4] and attributed to either of two causes: (i) change in electron orbits; (ii) precipitation of ferrous impurity[5]. It is considered in the present work that the decrease in diamagnetic susceptibility is not due to the presence of impurities. The reasons for this conclusion are (*a*) the metal is extremely pure; (*b*) the room temperature value of the susceptibility could be reproduced in the case of the cold-worked specimens after the specimen had been taken through a cycle at the higher temperature points; (*c*) complete absence of field-dependence of susceptibility; (*d*) had ferrous impurity in paramagnetic form been affecting the results, then the susceptibility would have been likely to diminish (numerically) at the low temperature, 90° K. Thus it is concluded that the decrease in diamagnetic susceptibility on cold-working indicates that copper is magnetically strain-sensitive.

Stoner[6] has suggested that increase in paramagnetic susceptibility with rise in temperature found by Sucksmith[7] in the alkali metals is due to thermal expansion. He deduces the approximate expression for the gram-atomic susceptibility for the quasi-free electrons:

$$(\psi_A)_o \times 10^6 = 32{\cdot}1\,(q/V_o)\{1 - 6{\cdot}11 \times 10^{-3}\,(T/V_o)^2\},$$

where q is the number of quasi-free electrons per atom and V_0 is the value of the maximum electron energy at absolute zero expressed in equivalent volts. Thermal expansion decreases V_0 and hence increases $(\psi_A)_0$. Cold-work, on the other hand, should also decrease V_0, since it may be considered as giving rise to a trapping of electrons in regions of lower potential energy. To account for the smaller decrease of susceptibility with temperature in the case of the cold-worked specimens, it is then necessary to suppose that further decrease in V_0 is less than for the annealed metal.

Further work will be published elsewhere.

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'Incipient Shrinkage' of Collagen and Gelatin

IT is well known that if collagen is heated in water to about 62° C. it undergoes shrinkage, and that if it is then allowed to dry, its ability to re-hydrate on immersion in water is considerably reduced. Although opinions differ as to the precise mechanism of hydrothermal shrinkage, the phenomenon is generally agreed to be a cumulative effect in which the polypeptide chains, by the rupture of certain cross-links of various strengths, assume a more compact space arrangement than their hitherto extended forms. On drying in this compact state, their ability to take up water is considerably reduced, due probably to the formation of fresh inter-chain links.

A similar reduction in the re-hydrating power of collagen, but not accompanied by shrinkage, can be obtained by heating it in an atmosphere of high relative humidity at temperatures so low as 45° C. Deaminated collagen and gelatin also show this effect, and in the case of gelatin, it is accompanied by an elevation in 'melting point', which may amount to as much as 50° C. or more, where thin gelatin layers are concerned. Under conditions of very high relative humidity (*c.* 100 per cent) gelatin undergoes marked hydrothermal shrinkage at 45° C., and exhibits rubber-like properties similar to shrunken collagen, a phenomenon not usually observed with gelatin on account of its ready solubility in water at about 35° C.

The accompanying table shows the magnitude of the changes in absorption of water of the three proteins referred to, brought about by heating in atmospheres of various relative humidities at 45° C. In each case, after heating at 45° C., the protein was allowed to come to equilibrium with an atmosphere of 70 per cent relative humidity at 20° C., and in no case did the final weight differ from the original, before heating, by more than 1 per cent. The water absorption figures indicate the grams of water absorbed by 100 gm. of protein when immersed in distilled water at 20° C. for three days in the case of the collagens, and 36 hours in the case of gelatin.

Protein	Period of heating at 45° C. (days)	Relative humidity (%) 54	69	82	*c.* 100
Collagen	5	126	124	113	111
	20	104	103	93	88
	80	97	94	90	75
Untreated collagen, 126 : shrunken* collagen, 95					
Deaminated Collagen	5	100	102	100	92
	20	86	89	89	76
	80	85	84	74	58
Gelatin	5	645	643	567	435†

* Collagen shrunken by immersion in distilled water at 90° C. for 3 min., allowed to dry out at 20° C. Some gelatinization had occurred, and therefore the water uptake figure given is probably higher than the real value for shrunken collagen.

† Hydrothermal shrinkage observed.

Air-dried collagen, containing about 13 per cent of water, can be heated in air to at least 100° C. without showing signs of shrinkage. Only when heated at this temperature in an atmosphere of practically 100 per cent relative humidity, or in the presence of excess water, does shrinkage occur. Since heating a protein in an atmosphere of high relative humidity is merely equivalent to heating it under conditions of comparatively high water content, it is apparent that a certain minimum water content is necessary before shrinkage can take place, even at temperatures so high as 100° C.

It seems likely that the effect which has been described is due to the rupture of some of the weaker cross-bonds of the protein molecule, which permits local increases in compactness, followed, on drying, by the formation of new cross-bonds. Physical shrinkage is not observed since insufficient links are so affected.

On this hypothesis, the term 'incipient shrinkage' seems appropriate to describe the phenomenon.

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Exchange between Chromium Ions and the Szilard Effect

CHROMIUM hydroxide ($Cr(OH)_3$) was subjected to the action of slow neutrons produced by the cyclotron of the Collège de France and was then transformed into the sulphate by dilute sulphuric acid. Potassium dichromate was added to this solution of the sulphate so as to obtain an equimolecular system of Cr^{+++} and $\frac{1}{2}$ $Cr_2O_7^{--}$. After a time which varied from 15 to 120 minutes, the chromic salt was precipitated by boiling with ammonium hydroxide and the dichromate as the barium salt.

The activities of these precipitates, as measured by a Geiger–Müller counter, showed that in the neutral or acid medium there was no appreciable exchange. The following, for example, are the results obtained for a solution of *p*H about 3.

Time of contact	$Cr(OH)_3$	$BaCrO_4$
15 min.	116 ± 10	10 ± 7
60 "	81 ± 10	0 ± 6
120 "	71 ± 10	7 ± 6

Potassium iodide, which catalyses the exchange between arsenite and arsenate, has no action in our case.

The impossibility of observing an exchange between the Cr^{+++}, $Cr_2O_7^{--}$ ions leads one to think that it would be easy to find a Szilard and Chalmers

effect with the dichromate. 500 gm. of dichromate were, therefore, irradiated with neutrons and dissolved in several litres of water which contained 200 mgm. of chromium sulphate. The latter was precipitated by ammonia and the hydroxide separated by centrifuging. The activity of the precipitate was found to be of the order of 100–300 counts/min., whereas the total activity of the dichromate was 30,000 or more counts/min.

Thus, if a Szilard and Chalmers effect does exist in this case, it is extremely weak.

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Jan. 20.

Evidence for the Formation of a Copper Carbonyl

In order to explain the 'metallization of insects' observed by Zelinski[1], and his own observation of a copper mirror produced by passing carbon dioxide through a heated tube containing a mixture of copper oxide and charcoal, Bertrand[2] postulated the intermediate formation of a copper carbonyl. Mond and Heberlein[3], being unable to reproduce Bertrand's results, were of the opinion that the deposition of the copper mirror was caused by the adhesion and sintering of copper oxide helped by its heat of reduction by carbon monoxide. The existence of a copper carbonyl has also been postulated by Boomer, Morris and Argue[4] to explain the removal of copper from the metallic catalyst during the synthesis of methanol.

In order to remove traces of oxygen from carbon monoxide, I heated a roll of copper gauze (initially slightly oxidized at the end of the roll nearest to the point of entry of the gas) in a glass combustion tube, by means of an electric furnace, the temperature in the centre of which was maintained at about 550° C. while the carbon monoxide (containing a little air, but no chloride) was being passed through the tube. During the course of several weeks of continuous heating in the stream of carbon monoxide, a substantial copper mirror was formed in the section of the tube which had attained a temperature of about 250–400° C., and a purple mirror in the centre section (550° C.). As the copper gauze was only in contact with the glass tube at a few points, and copper is non-volatile at the temperatures of the experiment, this phenomenon can best be explained by the formation of a very minute quantity of copper carbonyl at about 250° C., and its subsequent decomposition at higher temperatures. The purple coloration is due to interaction between the deposited metallic copper and the glass at the highest temperature (cf. Mond and Heberlein). A similar experiment using nitrogen instead of carbon monoxide did not produce a copper mirror, the glass tube remaining quite clear.

The fact that a copper mirror was deposited in a part of the tube where no copper oxide was present at any time means that Mond's criticism of Bertrand's experiments is inapplicable in this case. A minute deposit of a brown substance (free from chloride) in the cooler part of the glass tube may be the actual carbonyl. Tests were made for the presence of a chloride impurity, which could produce a white sublimate of cuprous chloride (cf. Robinson and Stainthorpe[5]), but this was found to be absent.

It is planned to carry out further investigations on this subject.

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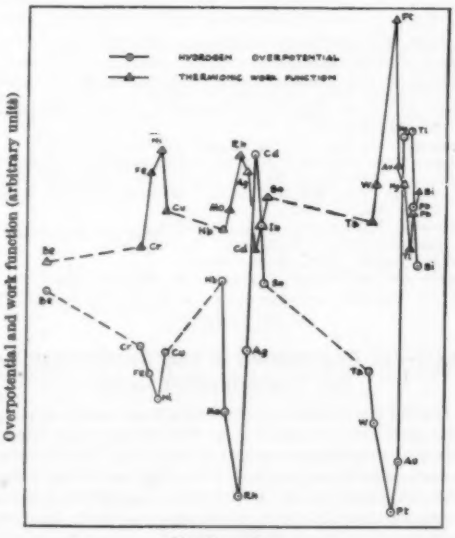
Hydrogen Overpotential and the Thermionic Work Function

Extensive recent work[1,2] on the hydrogen overpotentials at a large number of metal electrodes in aqueous solution allows a re-evaluation (see ref. 3) to be made of the relation between the hydrogen overpotential at various cathodes and the position of the cathode material in the periodic table. In the accompanying graph, the available values[1,2] for the hydrogen overpotential at the intermediate current density of 10^{-3} amp./sq. cm. at various cathode materials, the surfaces of which have been prepared in approximately the same way, are shown in relation to the atomic number of the metals concerned, from which a periodic variation may clearly be discerned.

It is of interest to compare this variation with the corresponding one for the thermionic work functions of the metals[4]. From the graph it seems that if, on transition from one metal to another, the second has a smaller overpotential than the first, then the second has a larger work function than the first, and *vice versa*. This relation appears to hold in every case for which data are available. There is also a general tendency for metals at which there is a comparatively low overpotential to have a comparatively high work function. The tendency for the converse is less marked.



According to Gurney's theory of hydrogen overpotential[5], the potential of a working electrode is directly related to its work function, and it appears from the theory that a high work function should tend to be associated with a large overpotential. According, however, to Adam[6], no relation between work function and overpotential is indicated by Gurney's theory, because "although electrons have to be extracted from the metal, they do also in a reversible electrode, and in either case the [work functions] cancel out . . . through a second contact potential elsewhere in the circuit". Both these interpretations seem in disagreement with the observed relations; the latter appear at variance in general with theories of hydrogen overpotential which postulate that the transfer of an electron from electrode to ion is the slow stage in the reactions occurring at the cathode[7,8].

As the work function of a metal is a measure of its electron affinity, it must be a measure of the tendency of the metal to take an electron away from the hydrogen atom and bind it to itself. Thus, it might be expected that the work function of metals would run roughly parallel to the ability of the latter to adsorb atomic hydrogen. Metals of comparatively high work functions, for example, nickel and platinum, would thus be expected to tend to act as comparatively good catalysts for the formation of molecular from atomic hydrogen. If, therefore, it be assumed that a catalytic reaction of adsorbed hydrogen forms the limiting stage in hydrogen overpotential, it follows that a large work function should correspond to a low overpotential, and the general features of the graph become more intelligible.

It may finally be noted that the order of increasing activation overpotentials of the metals is roughly the converse of their order with respect to hydrogen overpotential[9,10]. Thus for metal overpotentials, where the probability of a catalytic mechanism is remote, there appears to be a rough parallelism between work function and overpotential, as would be expected from the neutralization theory[11].

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[9] Clark and Frölich, *Z. Elektrochem.*, **31**, 649 (1925).
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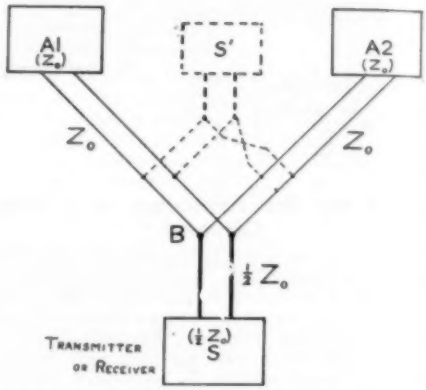
Apparent Breakdown of the Reciprocity Law for Transmission Lines

Radio-frequency transmission lines are normally 'matched' for maximum power-transfer by making the load impedance as transformed by the line equal to the complex conjugate of the generator impedance. One consequence of the reciprocity theorem is that the same matching condition applies when the transmission takes place in the opposite direction, that is, the functions but not the impedances of the load and generator are interchanged. In an application to multi-element directive arrays, an apparent failure of this principle has been found. Further examination has elucidated the reason for the paradox, but as it is felt that the behaviour of such arrays for incoming radiation is not generally understood, the facts seem worth recording. Similar considerations may arise in other radio-frequency problems (for example, nuclear physics accelerators) where branching feeders are used.



Consider the system shown in the figure, where the parallel lines represent transmission line of the characteristic impedance indicated, omitting for the present the dotted lines. If $A1$ and $A2$ are aerials of impedance Z_0 each, the generator S feeds into $\frac{1}{2}Z_0$ due to the two loads being joined in parallel at B, so that the matching condition is that the impedance of S should be $\frac{1}{2}Z_0$, and pure travelling waves are generated in the feeders. For the case of reception of incoming radio waves, the matching condition appears not to be satisfied; for example, $A1$, having impedance Z_0, feeds into $\frac{1}{2}Z_0$ at B due to $A2$ and S in parallel, and one would expect reflexion of incident energy to occur at B. However, when transmitting, the aerial elements $A1$ and $A2$ were energized in phase, giving directional propagation—usually along the array-normal. For a received wave arriving along the array-normal, $A1$ and $A2$ will be energized in phase, and then it is easily shown that no energy is reflected at B, the system being equivalent to two generators of impedance Z_0 in parallel feeding a load of $\frac{1}{2}Z_0$.

Thus we see that although reciprocity does not hold for a part of a directive array considered separately, it holds for the complete system; and if the direction of radiation is reversed the matching condition is unchanged. Absence of reflexion at B only occurs for waves arriving along the array-normal (energizing $A1$ and $A2$ in phase). Waves arriving along another direction may energize $A1$ and $A2$ equally in antiphase; complete reflexion then occurs at B, all the energy being re-radiated, and none reaches the receiver, whatever its impedance. Incidentally, the resulting polar-diagram zero has an exact counterpart in the converse process of radiation from the array. For the general incoming wave both modes are excited, so that partial reflexion of energy occurs at B, just as it did in the case already considered in which only $A1$ was energized. The only matching condition which we can apply is that for the part of

the energy in the in-phase mode, which is just the reciprocal of the matching condition for the transmitting case. However, application of this condition does not preclude the reflexion of energy, as it would in a simple feeder system.

In a radar application described in detail elsewhere[1] this principle is extended by the addition of the feeders, shown dotted in the figure, giving a feeder bridge having four arms each $\lambda/4$ long. By this means the energy in both modes (phase and antiphase at $A1$ and $A2$) can be absorbed, one mode into each of two receivers, the array then giving two polar diagrams simultaneously and quite independently into the two receivers. In such an arrangement neither receiver absorbs any power which could have reached the other receiver, even if that had been the only receiver present, but receives only energy which would otherwise have been re-radiated by the array.

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Spiral Cracks in Glass Tubing

Dr. J. J. Hopfield's description of spiral cracks in glass capillary tubing[1] reminds us that similar cracks were observed some ten years ago with thin-walled tubing, during the development of 'flashed' sodium-resistant glasses. The tubing in question was a conventional soda-glass, about 5 mm. in external diameter and rather less than 1 mm. in wall thickness, flashed internally with a thin layer of rather weak sodium-resistant glass. Specimens of such tubing in which the expansions of the two glasses were not sufficiently closely matched developed, soon after drawing, spiral cracks. The pitch of the crack increased towards the end of the stick of tubing, as in the specimen described by Dr. Hopfield, and tended to become infinite. In addition, the slope of the spiral varied throughout each turn in a regular manner. Cracks of the type described were only found in tubing having very high strain between the flashing and the base glass, the circumferential tension in the flashing glass corresponding to a stress of about 200 kgm. per sq. cm., a figure of the same order as the average breaking stress of the glass.

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[1] *Nature*, **158**, 582 (1946).

Friction and Wear

In the literature of friction it has been generally assumed, often implicitly, that there is no causal relationship between wear and friction. Schnurmann[1] has shown that the results of measurements of static friction on naked cadmium surfaces at temperatures down to − 100° C. indicate that abrasion cannot be the only factor responsible for the elementary mechanism of friction, and that an essential part is played by deformation. The following treatment, however, provides direct evidence for this lack of a causal relationship. It is shown that the work involved in that portion of the abrasion which actually results in wear is a negligible proportion of the frictional work.

The amount of work required to abrade material from the bearing surface will be a maximum if this material is all removed as single atoms, and this maximum amount of work may, therefore, be calculated from thermochemical data leading to the heat of atomization of the materials involved. If the frictional force operating during a wear determination is measured, we can then calculate both the total frictional work and the maximum work necessary to produce the observed amount of wear.

For a composite material containing 69 per cent by weight of calcite and 31 per cent by weight of an *o*-cresol formaldehyde resin of approximate empirical formula (C_8H_8O) tested against mild steel with a normal pressure of 50 lb./sq. in. at a speed of 50 ft./sec., the highest wear recorded corresponded to abrasion of 1 gm. for the expenditure of 726 kcal. of frictional work. The approximate heat of atomization of the material may be derived from the published values of the heat of formation of calcite, the heat of combustion of *o*-cresol with allowances for the additional atoms and bonds involved in the resin, and the heats of combustion and of atomization of the elements involved.

The heat of atomization of 1 gm. of the material is thus found to be 10·6 kcal., or 1·4 per cent of the total frictional work done. It follows, therefore, that the proportion of the frictional work to be ascribed to this abrasion process is probably several orders of magnitude less than 1 per cent, when allowance is made for the abrasion of particles considerably larger than single atoms.

The wear of the steel bearing-member was not measured in the above work and was not allowed for in the calculation. It was measured in another experiment in which it was known to be very much larger, and even in this case a similar calculation showed that it could not account for more than 1 per cent of the total work done. The above conclusion is therefore not affected.

In order not to prejudice the argument, high values have been used in the thermochemical calculation for those quantities the true values of which may still be open to question, for example, the latent heats of vaporization of calcium and carbon.

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Control of Low-Temperature Injury in the Victoria Plum

It is well known that many kinds of fruit and vegetable after picking may be damaged during storage at low temperature above the freezing point. The phenomenon has been widely studied, and there is a considerable literature on the low-temperature injury relations of the apple, plum, peach and grapefruit. That the conditions known as low-temperature internal breakdown of the apple and plum, as well as woolliness of peaches and pitting of the rind of grapefruit are the final and visible result of a series of

reactions deriving from an initial and sustained shift of metabolic balance, has seemed fairly evident. But observations of the influence of 'external' factors of primary importance, namely, level of temperature and duration of exposure as well as of 'internal' factors such as varietal type, degree of ripeness at picking, etc., have revealed a considerable complexity which cannot be elucidated by any simple hypothesis. It has, for example, been observed that after a limited period of exposure, the maximum percentage of injured fruits (plums and grapefruit) will often be found in samples subjected to storage at temperatures of an intermediate range. But after more prolonged exposure the highest proportion of injured fruits is found at the lowest temperature of storage.

Van der Plank and Rees Davies[1] have provided for these observations an ingenious explanation; they have suggested that the lower the temperature the greater is the amount of *actual* injury. But the lesser injury sustained at higher temperature becomes manifest more rapidly. Thus when the percentage of injured fruits after exposure of moderate duration is plotted against temperature of storage, a typical humped curve is obtained, which, however, with longer exposure becomes transformed to a sigmoid curve with a maximum at the lowest temperature and tailing to zero at some higher temperature. In its final form this curve represents the limit of manifest injury.

More recently, Plank[2] has criticized the theory of Van der Plank and Rees Davies and has suggested that there are two main types of reactions involved, one leading to an accumulation of a cell-poison (*Zellgift Bildung*) and the other to its removal (*Zellgift Veratmung*). The reaction velocities for the processes that lead to the accumulation of the cell-poison and for those which lead to its removal are both related to temperature by equations of the form

$$\log y = \log y_0 + at,$$

where y_0 is the reaction velocity for $t = 0°$ C. and a is its temperature coefficient. The values of a may vary within limits dependent upon the values of Q_{10} which are to be expected in the metabolism of plant tissue. By selecting values of a, he produces pairs of curves within the co-ordinates y and t which intersect at a critical value of t, that is, at which the rates of production and removal of poison are equated. For a given fruit of critical temperature t_K, exposure for any length of time to higher temperatures will not result in injury, but exposure to lower temperature will produce injury in longer or shorter time. From statistical considerations it is supposed that a given sample of fruits will have a frequency distribution of critical temperature, which will fit a curve of binomial form, and Plank builds curves based on the variations of the constants of his equations, resembling the experimental curves for low-temperature injury published elsewhere.

I have[3] previously raised the objection to an all-embracing theory of this sort for plums on account of the observed fact that at least two types of injury can be symptomatically distinguished, and that the form of the temperature-injury curve is more complex than that suggested by other investigators. Plank[4] assumes in explanation of my curves that there are two superimposed sets of processes, each tending to a distinctive end-point and with quite different reaction velocity constants.

Recent observations I have made are of interest both practically and in connexion with the above considerations, since they are not inconsistent with a theory of production and removal of a toxic substance. It has been found that when Victoria plums are exposed to a temperature of 31° F. for a period of five weeks, they are damaged to the extent of 100 per cent, the type of injury being that known as 'internal browning'. If, however, between the 15th and 20th day of exposure they are warmed to 65° F. and only returned to 31° F. after two days, they can then be exposed to the lower temperature for a further period of 15–20 days without injury. An extension of this further period beyond 20 days results in the appearance of internal browning. Warming on the 5th or 25th day only partially reduces the proportion of injured plums. Warming at day 0 (delayed storage) has scarcely any effect.

It is relevant to recall that Kidd and West[5] reported in 1935 a somewhat similar phenomenon when they subjected apples susceptible to a functional disorder known as 'superficial scald' to brief intermittent warming treatments when stored at 3° C. There resulted an almost complete control of scald.

These experiments, therefore, show that the life of the Victoria plum may be extended by as much as 50–75 per cent of that previously possible if the fruit is stored at 31° F. and warmed for two days between the 15th and 20th day.

The way, therefore, seems open to investigations which may possibly have some far-reaching effects upon practice in handling those types of fruits which are susceptible to low-temperature injury.

Details of these experiments are shortly to be published elsewhere, and further investigations along these lines are being projected.

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A Morphological Change Induced in Leaves of *Theobroma cacao* by Mineral Deficiency

Preparations for breeding a strain of *Theobroma cacao* L. resistant to the swollen-shoot virus which threatens the cacao industry of the Gold Coast[1] have included the collection of commercial types of *T. cacao* and of related species of *Theobroma*, some of which have been shown to give compatible crosses with *T. cacao*[2]. With the assistance of the Imperial College of Tropical Agriculture, seed from selected trees has been introduced to the Gold Coast from Trinidad. As a precaution against the introduction of witches' broom disease (*Marasmius perniciosus* Stahel) pods were surface-sterilized before dispatch by air; seedlings were quarantined for a minimum period of six months in Accra, which is twenty miles distant from the cacao-growing area.

Distressing signs of lime-induced chlorosis appeared in a number of early importations which had been potted in a mixture of soil, compost and marine sand containing a high percentage of shell, and had been watered with limed water. In addition to symptoms of acute iron deficiency, a few plants showed a leaf deformation which consisted of a number of sharp

dentations at the leaf tip: a normal cacao leaf is entire (Fig. 1).

This deformity has been reproduced in exaggerated form in cacao seedlings grown in water cultures lacking both iron and manganese. The basic solution of Reeve and Shive[3] was used at a potassium concentration of 50 p.p.m. with the addition of 0·5 p.p.m. each of boron and zinc. Plants were grown in blackened glass jars of 800 ml. capacity; the solutions were aerated daily and adjusted weekly to a reaction of *p*H 6·0. There were four replicates of the treatment, each of which produced deeply indentate leaves (Fig. 2) in a flush of growth developed in eleven to thirteen weeks after transference to culture. Eleven out of a total of fifteen leaves were affected; they were chlorotic and afterwards developed tip scorch (Fig. 3). The plants ceased elongation after twenty weeks in culture and produced no more leaves before dying.

The four plants had been taken at random from twenty seedlings which had been grown for eleven weeks in quartz sand and distilled water; the remaining sixteen seedlings produced entire leaves when grown under parallel conditions in solutions containing 1·0 p.p.m. iron and 0·25 p.p.m. manganese. Only entire leaves have been formed by a second series of forty plants, including eight lacking only iron and eight lacking only manganese, which have been grown for periods of up to thirty weeks in the same basic solution.

Since leaf shape, particularly the degree of dentation, may be used to separate species in certain genera, any induced modifications are of general interest. Harder and his colleagues have produced a change from entire to dentate leaf form in certain succulent plants by increasing the length of day[4].

Fig. 1. Normal cacao leaf

Fig. 2. Indentate leaf from culture lacking iron and manganese

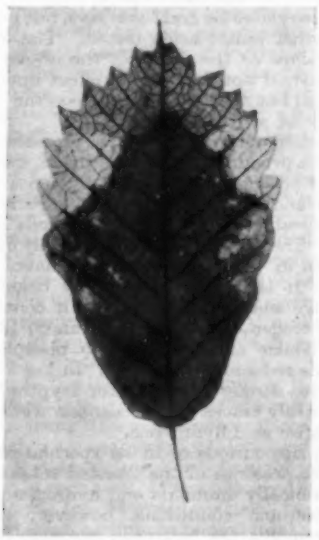

Fig. 3. Tip scorch developed by indentate leaf on ageing

They have shown that a leaf exposed to long days can transmit a stimulus which gives rise to long-day character in other leaves; the stimulus apparently travels in the plant along the same path as solutions injected through the petiole of the exposed leaf[5].

There would, however, appear to be no record of the production, by manipulation of the mineral nutrient supply, of a change of leaf shape comparable to that here described. While modifications of leaf size and thickness are associated with deficiencies of

a number of major and minor elements, changes in leaf outline are usually slight, the more notable being those accompanying zinc deficiency.

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Mechanism of Hydrogen Peroxide Formation by Spermatozoa and the Role of Amino-Acids in Sperm Motility

IT has been demonstrated[1], using freshly ejaculated bovine semen diluted with egg-yolk medium, that spermatozoa produce under aerobic conditions an inhibitor of sperm respiration. The inhibitor was afterwards identified chemically[2] as hydrogen peroxide, and was shown to be formed as the result of metabolic activity of spermatozoa upon a substance present in the egg-yolk and its dialysable portion. Since then, further purification and characterization of the egg-yolk substance have been carried out; and it has now been demonstrated that hydrogen peroxide is formed as the result of an oxidative deamination by spermatozoa of the substance isolated, which is replaceable, with the same effect, only by *l*-tryptophane, *l*-phenylalanine and *l*-tyrosine, but not by any of many other amino-acids tested. The inhibition which develops as the result of the above reaction can be detected not only by its effect upon oxygen consumption but also by its effect upon the reduction of motility of spermatozoa.

The isolation of the substance, in presence of which spermatozoa produce hydrogen peroxide, was effected by dialysis of egg-yolk, followed by successive precipitations and/or extractions with organic solvents of the dialysable portion or the fractions separated therefrom. The isolated substance is easily dialysable, and soluble in water, 90 per cent ethanol and *iso*-propanol. It is not fermentable by baker's yeast. Quantitative analysis revealed that it contains 10·7 per cent nitrogen, 4·2 per cent ash and 0·13 per cent sulphur (Weiler and Strauss), no phosphorus nor fermentable reducing substances. In low concentration it gives strong reactions for tryptophane and tyrosine. Only traces of glucosamine were detected before or after acid hydrolysis.

Washed suspensions of living spermatozoa of the bull, in the presence of the isolated substance, produced aerobically ammonia and hydrogen peroxide; under anaerobic conditions, however, there was neither ammonia nor hydrogen peroxide formation, and subsequent respiration and motility were unaffected. The ash of the substance had no appreciable effect on either respiration or motility. Spermatozoa inactivated by heat in presence of the substance and molecular oxygen produced neither ammonia nor hydrogen peroxide.

In view of the properties of the substance isolated, natural amino-acids were next tested individually as substrates for the metabolism and motility of bovine spermatozoa. This examination revealed that formation of ammonia and hydrogen peroxide, and subsequent inhibition of sperm respiration and motility, took place aerobically in the presence of only *l*-tryptophane, *l*-phenylalanine and *l*-tyrosine. There was neither ammonia nor hydrogen peroxide formation in the absence of oxygen or with heat-inactivated spermatozoa. The inhibition of sperm respiration and motility in presence of these substances was completely eliminated with added catalase (more than 10 μgm./4 ml. sperm suspension). In the presence of *dl*-alanine, *dl*-serine, *l*-cysteine, *dl*-valine, *l*-leucine, *l*-arginine, *l*-lysine, *l*-hystidine, *l*-aspartic acid and *l*-glutamic acid, there was no inhibition of either sperm respiration or motility, and no formation of ammonia or hydrogen peroxide.

These results suggest that the reaction by which hydrogen peroxide is formed by living spermatozoa is an enzymic dehydrogenation and deamination proceeding in the presence of molecular oxygen as hydrogen acceptor as follows:

$$R.CH_2.CH(NH_2).COOH + O_2 + H_2O \longrightarrow R.CH_2.CO.COOH + H_2O_2 + NH_3,$$

where *R* can be only phenyl, *p*-hydroxyphenyl or indolyl groups, but none of the other groups tested. The *l*-amino-acid oxidase (or oxidases) of living bovine spermatozoa, which affects only the three aromatic amino-acids, appears to be, therefore, more specific than the *l*-amino-acid oxidase present in some other animal tissues, which can utilize as substrates a much larger range of *l*-amino-acids[3,4].

These findings may have an important bearing on the fertilizing capacity of spermatozoa, and on their storage and survival in storage media, such as egg-yolk, and in natural secretions, especially in view of the fact that *l*-tryptophane, *l*-phenylalanine and *l*-tyrosine are widely distributed in animal tissues and body fluids. Moreover, the spermatozoa have an exceptionally low capacity for decomposing hydrogen peroxide; and hydrogen peroxide, even in very low concentrations which have not so far been chemically detectable, has a detrimental effect on the respiratory activity and motility of spermatozoa, as demonstrated by the elimination of these effects in presence of added catalase.

This work, carried out on behalf of the Agricultural Research Council, will be published in detail elsewhere.

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The Water-balance Principle of Crustacean Eye-stalk Extracts

IT has long been known[1] that extracts of crustacean eye-stalks contain a principle which not only influences the colour changes of crustaceans but also induces expansion of the melanophores in amphibians, acting in this respect like the intermediate lobe pituitary hormone. It was therefore of considerable interest when Gray and Ford[2] reported that extracts of crustacean eye-stalks produce an increase of water uptake in frogs similar to that observed after the injection of neurohypophysial extracts. No structure homologous to the vertebrate neurohypophysis has so far been identified in invertebrates; but the results of the American authors suggest the possibility that crustaceans, although they have no pituitary gland, elaborate pituitary-like hormones.

However, the similarity between the 'water-balance effect' of extracts of vertebrate pituitaries and that of extracts of crustacean eye-stalks is scarcely sufficient to characterize the eye-stalk factor as a pituitary-like principle. It was therefore decided to investigate whether crustacean eye-stalk extracts showed any of the other pharmacological actions of neurohypophysial preparations. Eye-stalks of the brackish water crab *Carcinus mænas* and of the fresh-water crayfish *Potamobius fluviatilis* were extracted according to the pharmacopœial method for the preparation of mammalian posterior pituitary extracts. Such extracts had a marked water-balance effect in frogs, but failed to give a significant pressor response in the spinal cat or an antidiuretic response in the unanæsthetized rabbit. Considering that most of the water-balance activity of mammalian neurohypophysial extracts is contained in the oxytocic fraction[3,4], the action of crustacean eye-stalk extracts on the isolated guinea-pig uterus was also examined. So was another action typical for the mammalian oxytocic fraction, namely, the action on the urinary chloride excretion in rats[5,6]. Negative results were obtained in both series of experiments.

No evidence could thus be obtained that the crustacean and the vertebrate water-balance factor are homologous principles: but although the water-balance activity of mammalian neurohypophysial extracts follows closely their oxytocic potency, it will have to be considered that this parallelism does not necessarily hold for non-mammalian pituitary extracts. For example, it has been shown[7] that frog pituitary extracts which per gland exerted a water-balance effect equivalent to that of 0·80 unit of the standard (mammalian) posterior pituitary extract, contained less than 0·04 unit of oxytocic activity. These results suggest that the vertebrate water-balance factor may have to be differentiated not only from the antidiuretic but also from the oxytocic pituitary hormone. It is therefore conceivable that a substance occurs in crustacean eye-stalk extracts which is related to the water-balance principle of vertebrate pituitaries but unaccompanied by any of the other neurohypophysial activities.

H. Heller
B. Smith

Department of Pharmacology,
University of Bristol. Feb. 20.

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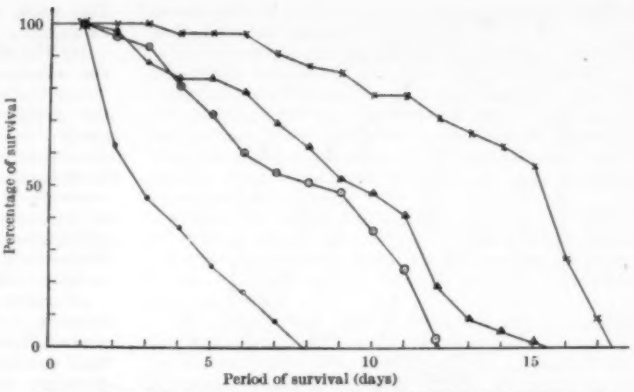

Fig. 1. Viability of *Echinorhynchus truttæ* in different concentrations of sodium chloride solution

●, 2 per cent sodium chloride. ×, 1 per cent sodium chloride.
▲, 1·5 " " " " ○, 0·75 " " " "

Acanthocephala of Trout and Anthelmintics: Behaviour *in vitro*

Practically nothing is known of the *in vitro* behaviour of Acanthocephala to anthelmintics, and standard works[1–4] say little about treatment of these parasites *in vivo*. Although *in vitro* tests may possibly not reproduce exactly the response of helminth parasites *in vivo*, they give an opportunity of comparing directly the action of a large number of drugs in a shorter time; and results so obtained may suggest a method of combating Acanthocephala in the living host. With these objects in view the present investigation was carried out.

Echinorhynchus truttæ (Acanthocephala), a common parasite of the brown trout (*Salmo trutta*), was selected for experiment. The most active worms were used. Contact with metallic instruments and exposure to light were avoided, as these were found to have a deleterious effect on the parasites and hastened their death. In the survival experiments in various concentrations of saline, 288 individuals were used; and 330 in the experiments with various drugs.

The worms were kept alive in saline solution. According to Van Cleave and Ross[5], a 0·85 per cent sodium chloride solution is a suitable medium for maintaining the Acanthocephala of the turtle. For *Echinorhynchus truttæ*, however, a 1 per cent solution of sodium chloride appeared to be most suitable. In this solution the majority of the parasites retained their normal wrinkled appearance and survived for more than two weeks. In lower concentrations of saline the Acanthocephala became plump and showed bulging of the body cuticle, while in higher concentrations they assumed a more or less shrunken appearance; and in both cases the period of survival was considerably shortened (Fig. 1).

For testing the *in vitro* behaviour of the parasites to anthelmintics, a large number of experiments was carried out using different concentrations of various drugs which were suspended or dissolved in a 1 per cent sodium chloride solution. Control experiments were set up in each case. It was observed that certain anthelmintics, for example, carbon tetrachloride, thymol and copper sulphate proved fatal to the parasites at a concentration of 0·05 per cent and more (Fig. 2), while others, for example, santonin and sulphathiazole, did not produce any visible toxic effects even when used in a 1 per cent concentration. Oil of chenopodium usually killed the Acanthocephala if used at a concentration of at least 1 per cent; concentrations less than 1 per cent merely paralysed the parasites, which revived when afterwards transferred to a 1 per cent sodium chloride solution.

Without cytological examination it would be difficult to determine the exact nature of the damage caused by the anthelmintics to these Acanthocephala

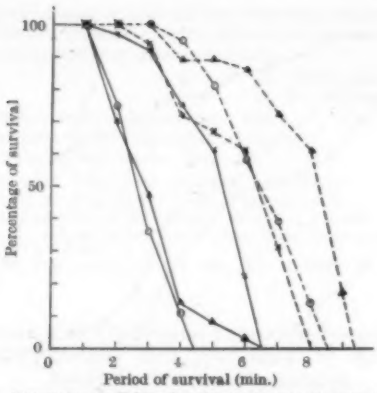

Fig. 2. VIABILITY OF *Echinorhynchus truttæ* IN 0·05 AND 0·1 PER CENT CONCENTRATIONS OF CARBON TETRACHLORIDE, THYMOL AND COPPER SULPHATE
.... 0·05 per cent. ○, carbon tetrachloride.
—— 0·1 " " ▲, thymol.
×, copper sulphate.

of the trout. The behaviour of the parasites, however, varied according to the drug used and its concentration. Both carbon tetrachloride and thymol brought about a rapid extroversion and introversion of the proboscis, accompanied by alternate expansion and contraction of the body. The movements were accelerated when higher concentrations of these drugs were employed. With these anthelmintics, the worms generally died in a fairly extended condition. Copper sulphate did not produce such marked effects, and with it there was scarcely any apparent difference in the activity of the Acanthocephala in different concentrations (0·05 per cent and 0·1 per cent solutions) except for a slight shortening of the period of survival in the higher concentration. With oil of chenopodium the worms showed a rhythmic expansion and contraction of the body, followed by a general wriggling movement. The body ultimately contracted and sometimes became S-shaped before the parasites finally became quiescent.

I take this opportunity of expressing my gratitude to Prof. James Ritchie for granting me facilities to work in his laboratory, and for the interest he has shown in my work.

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Zoology Department,
University of Edinburgh. Jan. 7.

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"Criteria of Hybridity"

I REGRET that ambiguity in my article "Criteria of Hybridity"[1] has caused Prof. E. Anderson inconvenience. While discussing the 'index method' of investigating natural populations, I made the statement: "In the majority of cases known to the author where this method has been employed . . . its use has not been preceded by an artificial cross between the putative parent species, differences between those species being all that were known before the natural populations were investigated. The work of Goodwin . . . with *Solidago* is an exception."

By this statement it was intended to convey that the references quoted were the cases known to me where the method had been employed, and that in the majority of them an artificial cross had not been made. I feel that no one who is familiar with the excellent and extremely productive work of Anderson on the populations of *Tradescantia* in America will be unaware of the artificial crosses made and published by him[2] involving species concerned in two of the references (Anderson[3] (Section II), Anderson and Hubricht[4]). In any event such crosses are referred to in both publications.

Goodwin's work was picked out as exceptional because it included a character-analysis of parents and artificial reciprocal crosses carried into the second filial generation and including back-crosses to both parents. In the remaining four papers quoted there is no mention of artificial crosses having been made prior to field investigations, and they are, therefore, in the majority. In this amplification of my original statement, it may be pointed out that Ownbey and Weber[5] do not, themselves, state that they have used the 'index method' or publish keys, but I believe that reasoning of this sort was necessary to obtain the results which they report.

The quotation from Anderson[3] which appears in the same paragraph of my paper is taken from his Section I ("A Method of Measuring Species Hybrids") which is not concerned directly with *Tradescantia*, and the remarks made still stand, as the necessity for prior experiment is not insisted upon in describing the method.

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The Premaxilla and the Ancestry of Man

PROF. WOOD JONES' theory of human evolution based on the premaxillary bone is, of course, well known[1]. It depends on his assumption that it is legitimate to infer the phylogenetic antiquity of a morphological character by noting the time of its ontogenetic appearance. However, attention is invited to Ashley-Montagu's comprehensive study on the premaxilla of the primates[2], in which the author reports that the apical portion of the premaxilla may in some cases be observed on the facial aspect of the late fœtal and infant human skull, quite clearly separated from the maxilla by a distinct suture. I have recently had the opportunity of studying the original fossil Australopithecine material in South Africa, and gave particular consideration to the architecture of the upper jaw. There appeared to be no feature here which contradicts the conclusions put forward by Prof. R. A. Dart and Dr. R. Broom that the Australopithecinæ do indeed give very important information regarding the primate forms which were ancestral to *Homo*.

W. E. LE GROS CLARK

Department of Human Anatomy,
University Museum,
Oxford. April 2.

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[2] Ashley-Montagu, M. F., *Quart. Rev. Biol.*, **10**, 32 (1935).

PROCEEDINGS OF THE PAN-AFRICAN CONGRESS ON PREHISTORY

A GENERAL account of the Pan-African Congress on Prehistory was published in *Nature* of February 15, p. 216. The following records the proceedings of the business meetings and supplements the former article.

Sixty-three papers were communicated to the Congress, and, in addition, four symposia were held, dealing respectively with "Pleistocene Marine Terraces", "Fossil Man in Africa", "The Hand Axe Culture in Africa" and "Fossil Apes in Africa".

Three sub-committees were set up to deal with problems relating to: (1) geology and general palæontology, under the chairmanship of Dr. S. H. Haughton; (2) human palæontology, under the chairmanship of Dr. A. Galloway; (3) prehistoric archæology, under the chairmanship of Mr. A. J. H. Goodwin.

A number of important resolutions, arising out of the deliberations of these committees, were placed before the Congress in its final session and duly passed. The most important of these dealt with the question of terminology in the African Continent, and, among other things, it was decided that in future:

(i) The Hand Axe Culture in Africa should be referred to as 'Chelles-Acheul' with suitable regional prefixes, instead of using such terms as 'Chellean', 'Acheulean', 'Stellenbosch', etc.

(ii) That the term 'Tumbian' should be abandoned, as well as 'Kalinian' and 'Djokocian', and that in substitution thereof the term 'Sangoan', with suitable definitive adjectives, be used for the earlier stages of the culture formerly described by the above terms, and the term 'Lupemban' for its later stages.

(iii) That the use of the term 'Aurignacian' for the 'blade and burin' culture in Africa be abandoned in favour of the term 'Capsian' with suitable regional prefixes.

(iv) That the use of the terms 'Clacton' or 'Clactonian' and 'Levallois' or 'Levalloisian' to describe *techniques* of working stone be abandoned, and that these terms be confined only to describing cultures and that the techniques should, in future, be described as 'block-on-block' technique and 'facetted platform technique' respectively, with suitable definitive terms where necessary.

(v) That the terms 'Kageran', 'Kamasian', 'Gamblian', 'Makalian' and 'Nakuran' should be used throughout Africa to describe defined stratigraphical units, and based upon the established succession of faunas and deposits in East Africa.

Two permanent committees were set up to deal with the question of terminology in the fields of prehistory and quaternary geology respectively. It was decided that, in order to obviate the introduction of unsuitable terms into the literature of African prehistory, all workers should be invited to submit any suggested new names to the members of these committees for prior comment and advice. In this way it is hoped to avoid the creation of different terms for identical cultures in different parts of the Continent.

In its final plenary session, the Congress passed a number of resolutions addressed to Governments of countries in Africa, as well as to Governments of countries interested in research work of Africa, stressing the urgent need for further research work in the field of prehistory and quaternary geology, as well as human palæontology.

The Congress decided that, in view of the very important results achieved at this first Pan-African Congress on Prehistory, it was essential that the organisation should be set up on a permanent foundation. Rules and constitution were consequently drawn up and approved, and it was decided that a similar congress should be held at approximately four-yearly intervals.

While the Congress was in session, an official invitation was received from Field-Marshal Smuts for the Congress to hold its next meeting in the Union of South Africa in 1951, and this invitation was accepted.

The *Proceedings* of the Congress are now being prepared for publication, and many of the original papers that were communicated will appear in full. Advance orders for copies should be sent to the General Secretary, Pan-African Congress on Prehistory, P.O. Box 658, Nairobi, Kenya Colony.

RADIO-COMMUNICATION DURING THE WAR

AS already announced in *Nature*, the Radio Section of the Institution of Electrical Engineers held a Convention during March 25–April 2, at which about a hundred papers were presented describing the progress made in recent years in the subjects of radio-communication, broadcasting and certain types of navigational aids. The proceedings of this Convention, when published in the *Journal* of the Institution, will form a most useful record of war-time progress in radio research and development, complementary to that of the Radiolocation Convention held in 1946.

In his opening lecture on "Telecommunications in War", Sir Stanley Angwin gave some account of the remarkable achievements in this field in recent years, the success of which was undoubtedly due to very effective co-operation between the Government research establishments, the electrical and radio industry, and the Fighting Services.

The first three technical sessions were devoted to papers dealing with radio-communication over long distances and with the special problems encountered in the use of radio technique for military, naval and aeronautical communications. Owing to the limited range of radio frequencies which can be used for long-distance transmission, the band of frequencies allotted to each circuit must be used in the most efficient and economical manner possible. With this objective in view, considerable advances have been made in stabilizing the frequencies of radio-transmitters, in the use of single, in place of double, side-band modulation, and in the combined use of several adjacent narrow frequency channels keyed at a reasonably low speed for the purpose of sending messages between two points at very high speeds. In most forms of modern communication, whether for civil or military purposes, the radio-transmission path is merely a link connecting the land-line telegraph and telephone networks in the countries surrounding the terminal points. Recent developments have therefore taken account of the need for the systems of modulation adopted to be equally suitable for operating both the radio and land-line equipments.

In the application of communication to the modern very mobile army and to ships and aircraft, a number of severe limitations of space, size and weight are encountered; and the manner in which the corresponding electrical and mechanical problems have been solved were described in a series of papers dealing with this field. One of the outstanding achievements of the War was the development and use by the army of the No. 10 set, which, with a carrier wave-length of about 6 cm. and the use of pulse modulation technique, provides multiplex radio telephone facilities in an equipment of a highly mobile form. At the above wave-length the use of a large parabolic reflector gives a concentrated beam of radiation with a consequent high degree of privacy in communication. Although the effective range of each such set is in practice limited virtually to optical distances, the efficiency is such that many sets can be used in series; and it was in this way that Field-Marshal Montgomery was enabled to maintain direct telephonic communication with London during his advance through Germany.

While, as several papers described, the use of very high frequencies, corresponding to wave-lengths of a few metres and less, now plays an important part in communication, particularly for air-to-ground and other relatively short-distance operation, the bulk of long-distance communication is necessarily confined to those frequencies which are efficiently transmitted by reflexion from one or other regions of the ionosphere. In opening the session on "Propagation", Sir Edward Appleton described the British work on the exploration of the ionosphere during the past twenty years or more, and the manner in which such long-term measurements are applied to the prediction of average ionospheric conditions some months ahead. In a following paper, Messrs. K. W. Tremellen and J. W. Cox described the work of the Inter-Services Ionospheric Bureau, which was set up during the War to provide detailed forecasts of communication conditions as required from day to day for various parts of the world. The techniques thus evolved are being improved and applied to peace-time communication problems, the basic scientific work being carried out at the National Physical Laboratory under the auspices of the Radio Research Board of the Department of Scientific and Industrial Research.

At a later session, Mr. H. Bishop presented a paper in which he described the large and important part played by the Engineering Division of the British Broadcasting Corporation during the War. Very elaborate precautionary measures were initiated before the War, to ensure that the broadcasting stations in Great Britain did not provide navigational assistance to enemy aircraft, and these proved to be very successful in practice. In addition, the expansion and maintenance of adequate propaganda and information services to Europe and other parts of the world necessitated the provision of new transmitting stations of various types. As a result, Great Britain now has at Ottringham, near Hull, the highest-power medium-wave broadcasting station in the world, with an output power to the aerial of 800 kW. In addition, the world's largest short-wave broadcasting station has been erected at Skelton, in Cumberland, where twelve 100 kW. transmitters and a system of fifty-one aerials have been installed.

Other papers dealt with recent advances in radio direction-finding and certain types of navigational aids for ships and aircraft; and the Convention was brought to a close by a lecture by Sir Clifford Paterson, in which he reviewed the work of all the sessions and indicated the direction in which future progress in this subject is likely to be made. Much of the war-time experience will bear fruit in peace-time applications, particularly in connexion with civil aviation, trunk telephony, broadcasting, television and the industrial uses of radio frequency and electronics techniques.

FLUORIMETRIC ANALYSIS

A DISCUSSION was held in the rooms of the Chemical Society, Burlington House, on February 11, by the Physical Methods Group of the Society of Public Analysts, on "Fluorimetric Analysis".

The first paper was presented by Mr. E. J. Bowen as a basis for discussion of apparatus design. It was argued that although on occasion visual methods might be valuable in revealing unsuspected or unwanted changes in the colour of the fluorescence, photocell instruments have the advantage of simplicity of operation and high accuracy. The best design would seem to be a central lamp sending in opposite directions two horizontal light beams which are made parallel by lenses, monochromatic by filters, and controlled in area by diaphragms. The beams each traverse a rectangular transparent cell of solution, one a standard and the other the one to be measured. The fluorescent light emerging at right-angles to the beams is received (through filters) by two photocells connected in opposition. The measurements may be made either by the direct differential output of the photocells, or by balancing this to zero electrically or by a calibrated variable diaphragm in one of the light beams. The advantages of vacuum type photocells with valve amplification over barrier layer cells for this purpose were stressed, and it was pointed out that the still greater sensitivities obtainable with photo-electron multiplier tubes make them very suitable for fluorimeters to measure feeble fluorescence, and open up some interesting new possibilities.

A second contribution by Mr. Bowen dealt with the theoretical aspects of the 'quenching' of fluorescence in solution. It was suggested that this term should be confined to the phenomenon of the non-time-dependent weakening of the fluorescence of a substance below a 'fluorescence efficiency' of unity. This would rule out effects caused by instrumental errors or by residual unwanted fluorescence in the solvent, cells, or filters. The use of the term 'fluorescence fatigue' to describe examples of reversible photochemical action was criticized. A systematic classification of quenching processes into three main types was presented: intramolecular energy rearrangements, intermolecular effects, and inner filter action. Experimental methods of distinguishing these types, and of the two kinds of intermolecular effects, 'collisional' and 'compound' quenching, were described. The paper concluded with a brief account of the types of photochemical change often associated with fluorescent solutions.

Dr. E. Kodicek described precise methods he has worked out for the fluorimetric analysis of such substances as riboflavine, vitamin A, etc., as a means of investigating nutritional problems.

Dr. D. M. Simpson (Cambridge) gave a short account of the applications of fluorimetric analysis to the study of pterins. She emphasized the need for

the determination of standard spectra of synthetic pterins under controlled conditions of illumination and *p*H. At present such spectra are available only for xanthopterin and leucopterin.

Fluorescence spectra alone are insufficient to identify pterins in complex mixtures. Ultra-violet absorption spectra and chemical tests should also be employed. Using these complementary methods, it has been possible to demonstrate the presence of pterins in such diverse materials as the argentaffine cells of the stomach and intestine, the fluorescent substance obtained from the eye of the dog-fish (*Squalus acanthias*) and the 'uric acid pigment' prepared by heating uric acid and water in sealed tubes at 200° C.

Few quantitative determinations of the concentrations of pterins have yet been made using fluorescence spectra. Provided that suitable precautions are employed to avoid quenching and inner filter effects, the method should be feasible if synthetic material is available for comparison. Examination of a large number of liver extracts has suggested that the intensity of fluorescence might be used as a measure of the clinical activity of these preparations.

In discussion, Drs. Winch and Cooper described tests made with a G.E.C. photocell and valve with a grid-leak of 10^8 megohms, capable of detecting 10^{-11} lumens. The instrument can detect a concentration of 1 milli μ gm./c.c. of a fluorescent substance, below which the residual fluorescence or Raman radiation of the water interferes. Dr. Cooper criticized the use of double-beam instruments with a mercury lamp on account of the movements of the narrow arc thread with time. Dr. F. Wokes raised the question of temperature effects on fluorescence, and stressed the need for publication of adequate data on fluorimeter calibration in analytical papers. Dr. Ridyard welcomed clearer definitions of the term 'quenching' because of its relation to instrument design. He suggested that the device of a transparent glass plate at 45° to the beam to reflect some of the light might be a useful modification of the double beam arrangement. L. White suggested that a closer study of the types of quenching observed in different instances might prove a method of distinguishing substances with similar fluorescent emission. Dr. H. W. Thompson stated that the limiting factor of sensitivity in many fluorimeters is the fluorescence of the glass or gelatine filters used before the photocell. Drs. Griffiths, Gullerson and Ellinger also made interesting contributions to the discussion, which had been keen throughout and was brought to a close only by considerations of time and temperature.

RECENT SOLAR ACTIVITY

A PAIR of sunspots making a group of exceptional size crossed the sun's disk between March 31 and April 13 in lat. 24° south. The group was the return of that reported in *Nature* of March 22, p. 396, but meanwhile it had either grown or a new formation had developed, as seems more likely, giving an even greater area than during the first disk passage during March 3–17. This latest spot, with a peak area of about 5,400 millionths of the sun's hemisphere, now heads the list of the largest spots in the Greenwich photographic records begun in 1874–75. Even in the extended period covered by reliable drawings associated with Schwabe, Carrington and others, this spot probably holds its premier position for size. As will be seen from the list below, within fourteen months the largest four spots in the Greenwich record have occurred. For this alone, the present 11-year solar cycle will be remarkable, whatever further activity is in store during the next two or three years that should include the peak of spot-frequency of the cycle.

In one important respect, the latest spot has been surprising; no great magnetic storm, nor even a small one, occurred during the interval, two days before and four days after central meridian passage (April 6–8 U.T.), when great magnetic activity associated with big sunspots is most likely to begin. It is significant that available solar observations indicate an absence of marked chromospheric activity, especially intense solar flares, associated with the spot; but until central meridian passage few observations could be made in Great Britain owing to cloudy skies. However, radio data of fade-outs on short-wave long-distance transmission, as reported to the Royal Observatory, Greenwich, by Cable and Wireless, Ltd., entirely support the sampling from direct solar observation that no intense solar flare occurred over the spot when it was more nearly in line with the earth. Previous experience has shown that intense flares, such as those recorded with the two great sunspots of 1946, are synchronized by complete and prolonged fade-outs of an hour's duration or more on daylight circuits. The evidence for no intense flare will be virtually complete when similar data are obtained for daylight circuits during Greenwich night hours, in addition to solar observations made in America, Australia and India.

The list of giant spots that have exceeded 3,000 millionths of the sun's hemisphere on one or more days may now be given as follows. The areas given for the 1946 and 1947 spots are provisional only, pending the measurement at Greenwich of a completed series of photographs.

Year	Central meridian passage	Maximum area	Magnetic storm: Great or small	Magnetic storm: Begins
1947	April 6·8	5400	None	—
46	Feb. 5·5	4900	G	Feb. 7·4*
47	March 10·2	4300	s	March 8·3
46	July 26·8	3950	G	July 26·8*
26	Jan. 24·5	3716	G	Jan. 26·7*
38	Jan. 18·4	3627	G	Jan. 22·2*
37	Oct. 4·5	3340	s	Oct. 3·5
38	Oct. 11·9	3003	(s	Oct. 7·4)

An asterisk denotes that an exceptionally intense solar flare was observed in *Hα* (6563 A.) at one or more observatories at the following respective time-intervals preceding the beginning of the storm: 18, 26¼, 24 and 29 hours.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 21

INSTITUTION OF ELECTRICAL ENGINEERS (at the Central Hall, Westminster, London, S.W.1), at 6 p.m.—Mr. J. Hacking: "The Generation and Wholesale Distribution of Electricity" (Faraday Lecture).*

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (in the West Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6 p.m.—Symposium on "The Production and Care of Laboratory Animals", Part 2. Dr. H. J. Parish: "Common Diseases"; Mr. N. T. Gridgeman: "Records".

ROYAL STATISTICAL SOCIETY, SHEFFIELD GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (at the Royal Victoria Station Hotel, Sheffield), at 6.30 p.m.—"The Application of Statistical Control to Research and Testing".

Tuesday, April 22

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. W. A. J. Paul: "Photography in the Post Office".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. S. Rodda: "Electron Multipliers".

Wednesday, April 23

PHYSICAL SOCIETY (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Discussion on "The Spark Discharge" (to be opened by Prof. Leonard B. Loeb).

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Miss Caroline Haslett: "Electricity in the Home".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. D. Gabor: "New Possibilities in Speech Transmission".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting; Mr. T. Rundle: "Some Problems of Trade Effluent Disposal".

Tuesday, April 22—Wednesday, April 23

INSTITUTE OF PHYSICS, X-RAY ANALYSIS GROUP (at the Royal Institution, 21 Albemarle Street, London, W.1).—1947 Conference.

Tuesday, April 22

"Training of X-Ray Crystallographers for Science and Industry". At 9.30 a.m.—"Requirements of Industry and Training by Industry"; at 2 p.m.—"Training of X-Ray Crystallographers in Polytechnics and Universities"; at 8 p.m.—Mr. H. P. Rooksby: "The Technique of X-Ray Powder Photography".

Wednesday, April 23

"New Techniques and Results". At 9.30 a.m.—"New Methods and Results of X-Ray Analysis"; at 2 p.m.—"New Industrial Techniques and Results".

Thursday, April 24

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. A. Todd: "Combinants of Pencils of Conics and Quadric Surfaces".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Miss J. G. Marley: "A Statistical Survey of Certain Aspects of the Beef Producing, Dairying and Cattle Rearing Industries in Great Britain between 1939 and 1945".

INSTITUTION OF ELECTRICAL ENGINEERS (at Kingsway Hall, Kingsway, London, W.C.2), at 5.30 p.m.—Prof. L. B. Loeb: "Electrical Discharge through Gases" (Thirty-eighth Kelvin Lecture).

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. J. W. Drinkwater and Mr. W. G. Glendening: "The Risk of Fire and Fire Prevention Methods".

NORTHAMPTON POLYTECHNIC (at St. John Street, London, E.C.1), at 7.30 p.m.—Mr. A. J. Philpot: "Scientific Instrument Manufacture and the Nation".*

Friday, April 25

FEDERATION OF BRITISH INDUSTRIES (at the Merchants Hall, George Square, Glasgow).—Scottish Regional Conference on "Research and the Progress of Industry in Scotland". At 10 a.m.—"The Established Industries"; at 5.30 p.m.—"Balancing Scotland's Industries".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, POLAROGRAPHIC DISCUSSION PANEL OF THE PHYSICAL METHODS GROUP (in the Physical Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Dr. W. Cule Davies: "Remarks on Polarographs"; Dr. G. Jessop: "Notes on Polarographic Technique"; Dr. E. R. Roberts: "The Analysis of Brass Plating".

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM SECTION (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5 p.m.—Scientific Papers.

UNIVERSITY COLLEGE (at Gower Street, London, W.C.1), at 5.15 p.m.—Dr. J. F. Danielli: "Cell Physiology and Pharmacology" (other lectures on May 2, 9, 16, 23 and 30).*

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the MEASUREMENTS and TRANSMISSION SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. Casson and Dr. F. H. Last: "Ultra-High-Speed Relays in the Fields of Measurement and Protection".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. S. Timoshenko: "Stress Concentration and Fatigue Failures".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 5.45 p.m.—Annual General Meeting.

UNIVERSITY COLLEGE (at Gower Street, London, W.C.1), at 5.45 p.m.—Prof. R. O. Kapp: "The Presentation of Technical Information" (other lectures on May 2, 9 and 16).*

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Manchester Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. E. D. van Rest: "Probability and the Experimenter".

SOCIETY OF DYERS AND COLOURISTS, MANCHESTER SECTION (at the Gas Department Showrooms, Manchester), at 6.30 p.m.—Dr. G. L. Royer: "Studies on Rayon Dyeing—Application of the Dyeometer".

Saturday, April 26

ASSOCIATION OF SCIENTIFIC WORKERS, NORTH-WEST AREA (at Milton Hall, Deansgate, Manchester), at 2.45 p.m.—Delegate Conference on "Industrial Health".

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. J. Maddock: "Process Costing and Cost Control".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR SCIENTIFIC OFFICER IN THE PLANT BREEDING DIVISION of the Ministry of Agriculture for Northern Ireland—The Assistant Secretary (Establishment), Ministry of Finance, Stormont, Belfast (April 25).

LECTURER IN PHYSICS—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants. (April 26).

BIOCHEMIST—The Secretary, Animal Diseases Research Association, Moredun Institute, Gilnerton, Edinburgh 9 (April 26).

TEACHER (graduate) OF MATHEMATICS, a TEACHER (honours graduate) OF PHYSICS, and a TEACHER (graduate) OF PHYSICS AND CHEMISTRY—The Principal, Acton Technical College, High Street, Acton, London, W.3 (April 26).

LECTURER IN BIOLOGY with subsidiary Chemistry, and LECTURER (2) IN CHEMISTRY—The Principal, Municipal College, Romford Road, Stratford, London, E.15 (April 26).

LECTURER IN MATHEMATICS up to Higher National Certificate standard—The Principal, Handsworth Technical College, Golds Hill Road, Birmingham 21 (April 26).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT of the Croydon Polytechnic—The Education Officer, Education Office, Katharine Street, Croydon (April 26).

LECTURER IN ELECTRICAL ENGINEERING—The Principal, County Technical College, Dartford, Kent (April 26).

GRADUATE IN GENETICS, AGRICULTURE, VETERINARY SCIENCE OR PHYSIOLOGY, for work involving abstracting and preparation of reviews—The Acting Director, Imperial Bureau of Animal Breeding and Genetics, King's Buildings, West Mains Road, Edinburgh 9 (April 28).

RESEARCH POSTS IN THE DEPARTMENTS OF (*a*) BIOLOGY, (*b*) ANTIQUITIES, (*c*) ART—The Director, Museum and Art Gallery, New Walk, Leicester, endorsed with the appropriate words 'Keeper of . . .' (April 28).

CHAIR OF BOTANY in the University of Tasmania—The Agent-General for Tasmania, Golden Cross House, Charing Cross, London, W.C.2 (April 30).

DIRECTOR OF SURVEYING—The Registrar, King's College, Newcastle-upon-Tyne (April 30).

SCIENTIFIC OFFICER IN THE BLOOD TRANSFUSION SERVICE at Manchester—The Regional Blood Transfusion Officer, Royal Infirmary, Manchester (April 30).

WOOL RESEARCH SCHOLARSHIP founded by the International Wool Secretariat—The Registrar, The University, Manchester 13 (April 30).

ADVISORY OFFICER IN GRASSLAND HUSBANDRY—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (April 30).

LECTURER IN BACTERIOLOGY—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (April 30).

ASSISTANT LECTURER IN BOTANY—The Registrar, The University, Leeds 2 (April 30).

LECTURER IN EDUCATIONAL PSYCHOLOGY—The Registrar, The University, Leeds 2 (May 1).

TUTOR or ASSISTANT TUTOR IN BIOCHEMISTRY or PHYSIOLOGY—The Secretary, Somerville College, Oxford (May 1).

ASSISTANT PHYSICIST (full-time) in the L.C.C.'s Hospitals Service—The Medical Officer of Health (S.D.6), County Hall, London, S.E.1 (May 1).

LECTURER IN MATHEMATICS—The Registrar, University College, Singleton Park, Swansea (May 3).

LECTURER IN CIVIL AND MECHANICAL ENGINEERING, and a LECTURER IN WORKSHOP PROCESSES—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (May 3).

PRINCIPAL AGRICULTURAL AND HORTICULTURAL OFFICER AND PRINCIPAL OF THE FARM INSTITUTE—The Director of Education, Shire Hall, Nottingham (May 3).

LECTURER IN PHYSICS, a LECTURER IN CHEMISTRY (with special qualifications in physical chemistry), an ASSISTANT LECTURER IN MATHEMATICS (pure or applied), and an ASSISTANT LECTURER IN CHEMISTRY—The Principal, Royal Holloway College, Englefield Green, Surrey (May 3).

OFFICIAL FELLOWSHIP AND LECTURESHIP IN CHEMISTRY—The Rector, Exeter College, Oxford (May 3).

LECTURER IN TEXTILE TESTING in the Department of Textile Industries—The Registrar, The University, Leeds 2 (May 5).

ASSOCIATE AND FULL PROFESSORSHIPS IN THE DEPARTMENT OF PHYSICS—The Head of the Department of Physics, University of British Columbia, Vancouver, B.C., Canada (May 12).

ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY AND ANTHROPOLOGY, with special qualifications in Cartography—The Registrar, University College of Wales, Aberystwyth.

SPEECH THERAPIST—The County Medical Officer, County Hall, Hertford.

SENIOR LECTURER IN PHYSICS—The Clerk to the Governors, Wolverhampton and Staffordshire Technical College, Education Offices, North Street, Wolverhampton.

ASSISTANT LECTURER IN HORTICULTURE—The Registrar, University College, Exeter.

LABORATORY TECHNICIAN (Grade B) IN THE DEPARTMENT OF PHYSIOLOGY—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.1.

PHYSICIST to the Radiotherapy Department—The Secretary-Superintendent, Royal Sussex County Hospital, Brighton.

CHEMISTS (men and women, temporary) IN THE CHEMICAL INSPECTION DEPARTMENT of the Ministry of Supply—The Ministry of Supply, Est. 5 (B) 2, Room 828, Adelphi, London, W.C.2, quoting Chem. 6.

TECHNICIAN (Grade A) FOR THE REGIONAL SEROLOGICAL REFERENCE LABORATORY (Ministry of Health), Oxford—The Director of Pathology, Radcliffe Infirmary, Oxford.

HEAD OF THE SCHOOL OF PHARMACY—The Clerk and Treasurer, Dundee Technical College, Bell Street, Dundee.

PHYSICIST or ENGINEER for research into problems of lace manufacture—The Research Officer, Lace Federation Research Council, 71 Upper Parliament Street, Nottingham.